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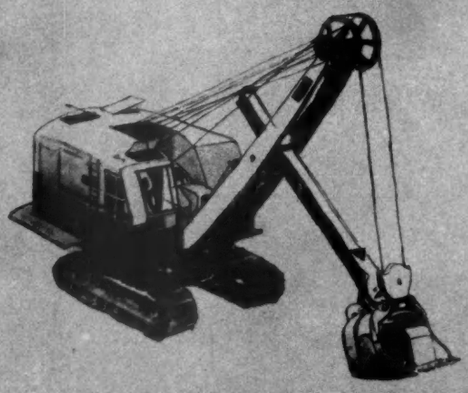

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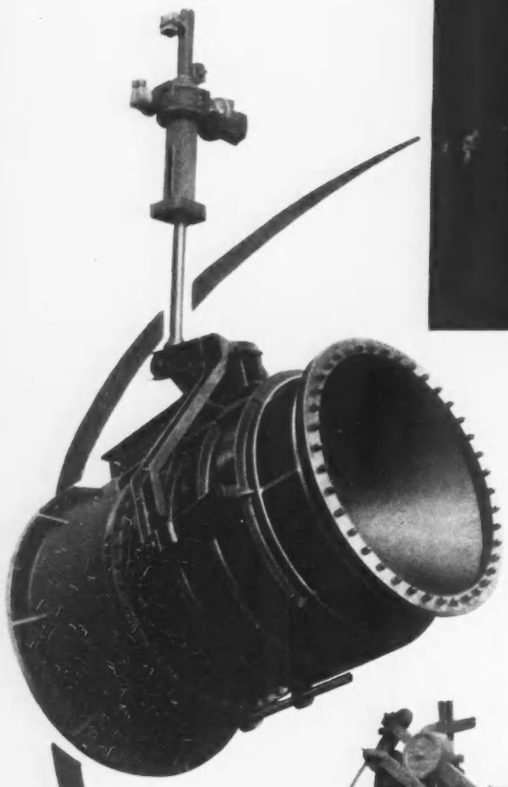

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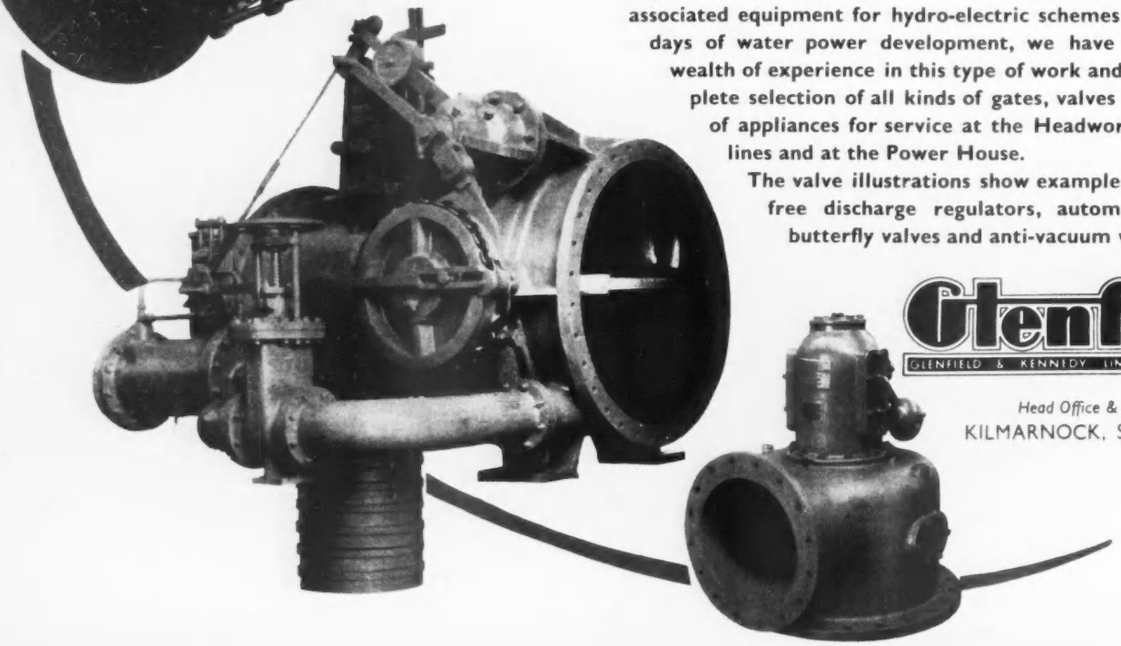

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THE ENGINEER

Established 1856

No. 5408 **SEPTEMBER 18, 1959** VOL. 208

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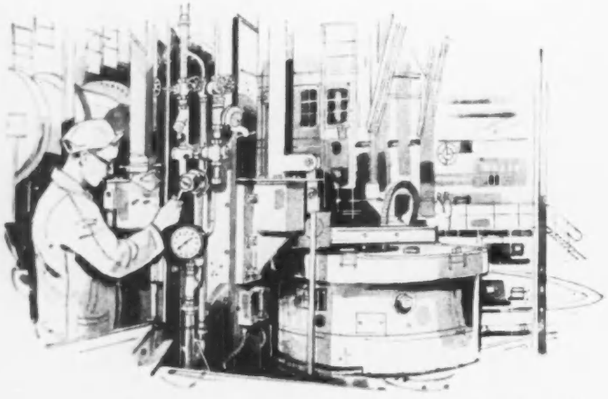

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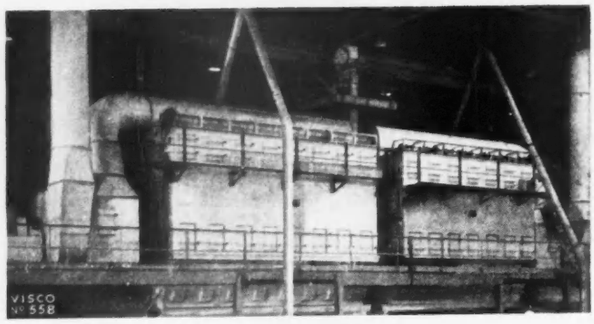

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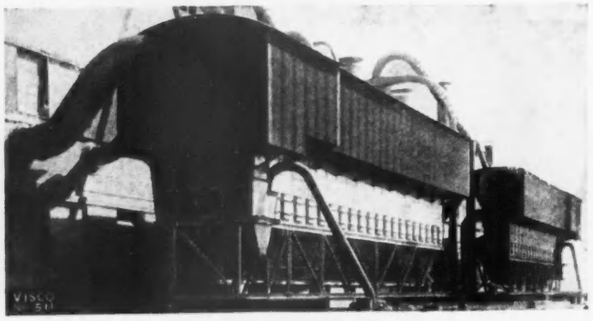

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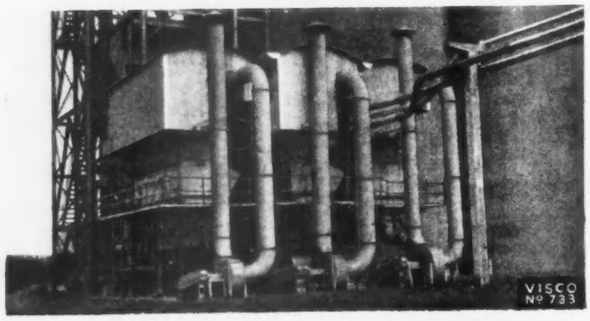

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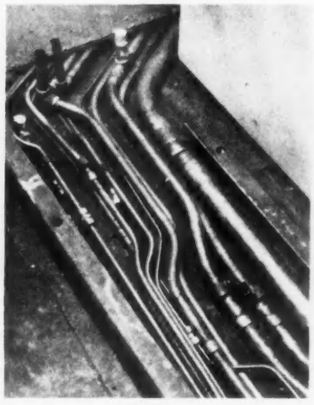

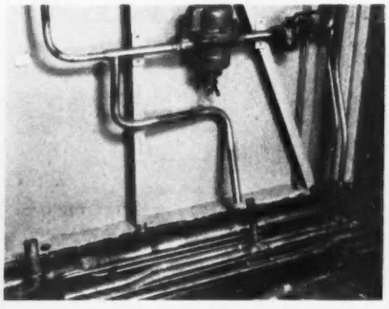

Photographs by courtesy of British Transport Commission

Above: Yorkshire Imperial Copper Tubes and "Yorkshire" Capillary Fittings on air brake and control piping in boiler compartment of British Railways Main-Line Diesel Electric locomotives, Type 2.

Left: Yorkshire Imperial Copper Tubes and "Yorkshire" High Duty and "Instantor" Fittings on air brake and control piping in engine compartment of the above.

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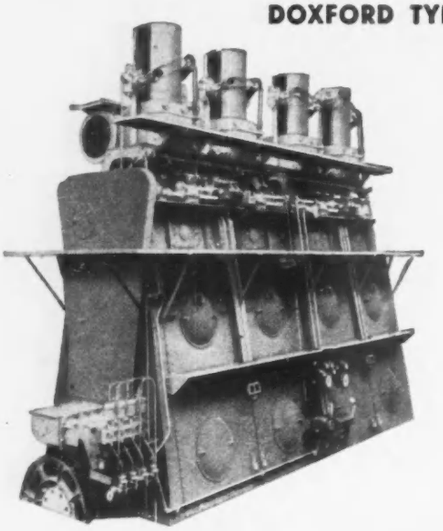

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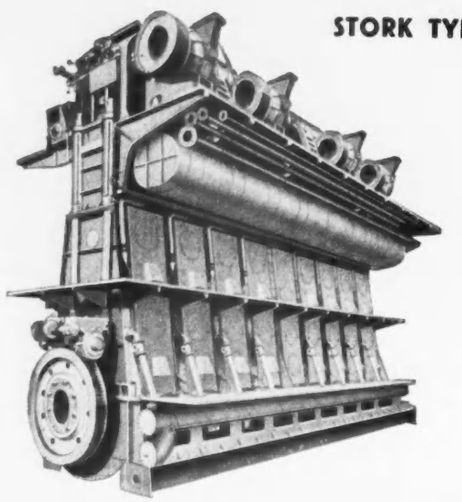

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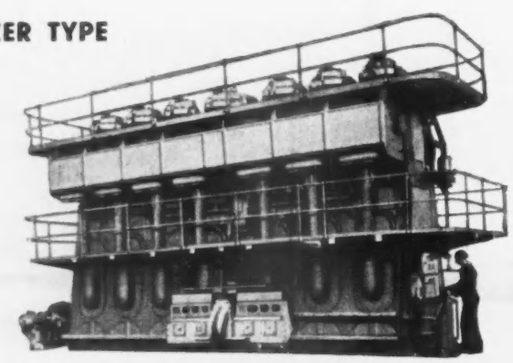

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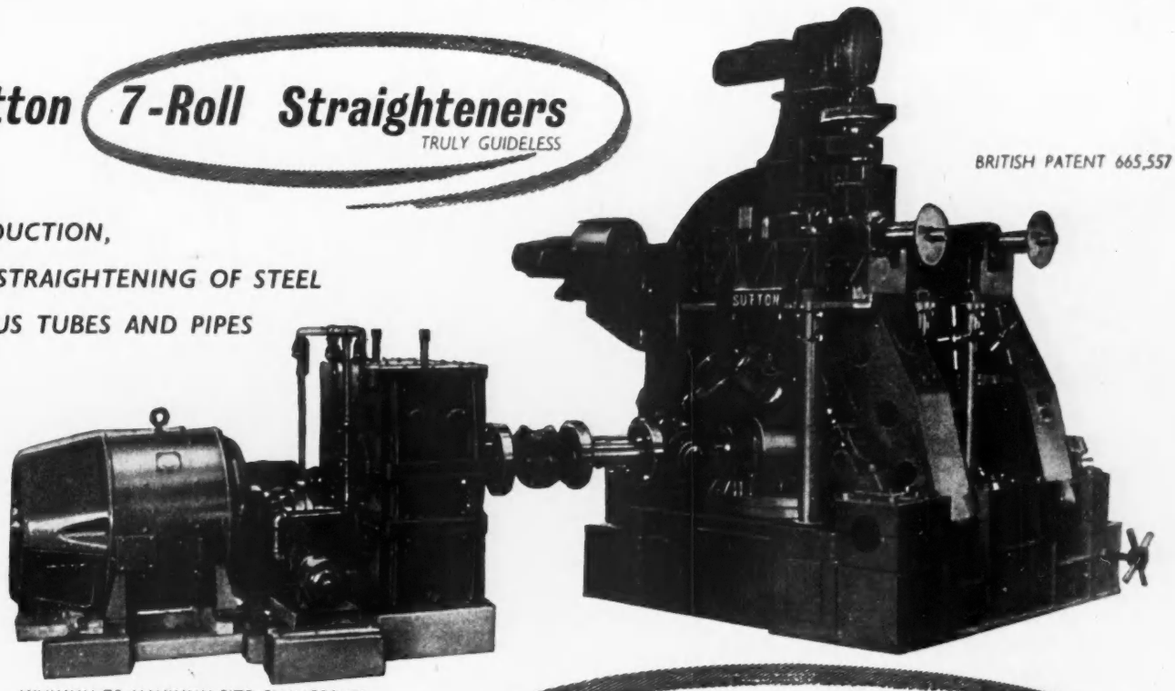

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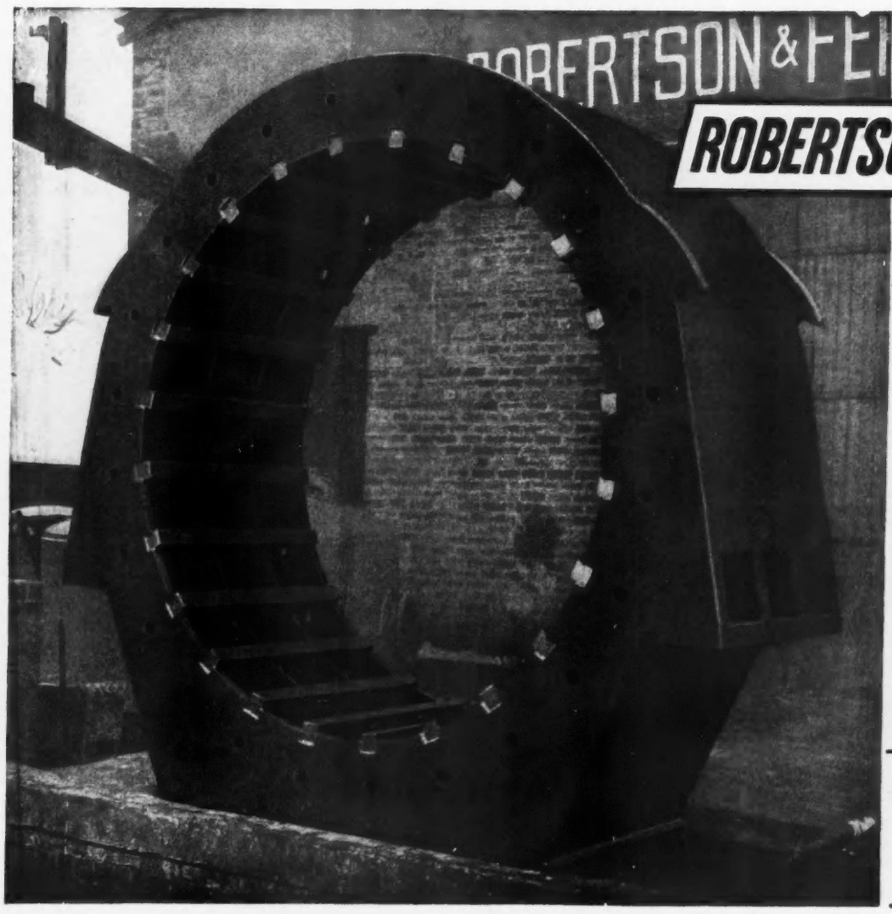

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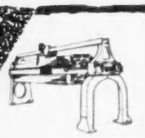

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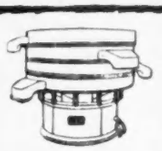

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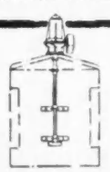

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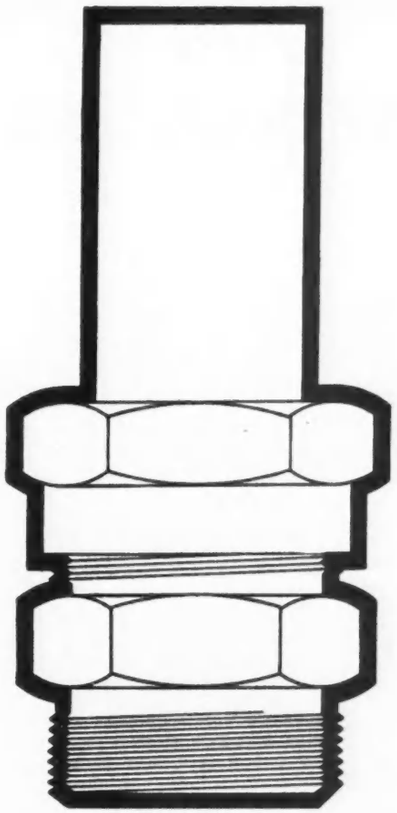

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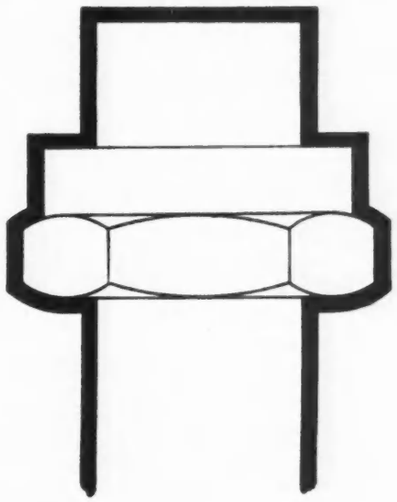

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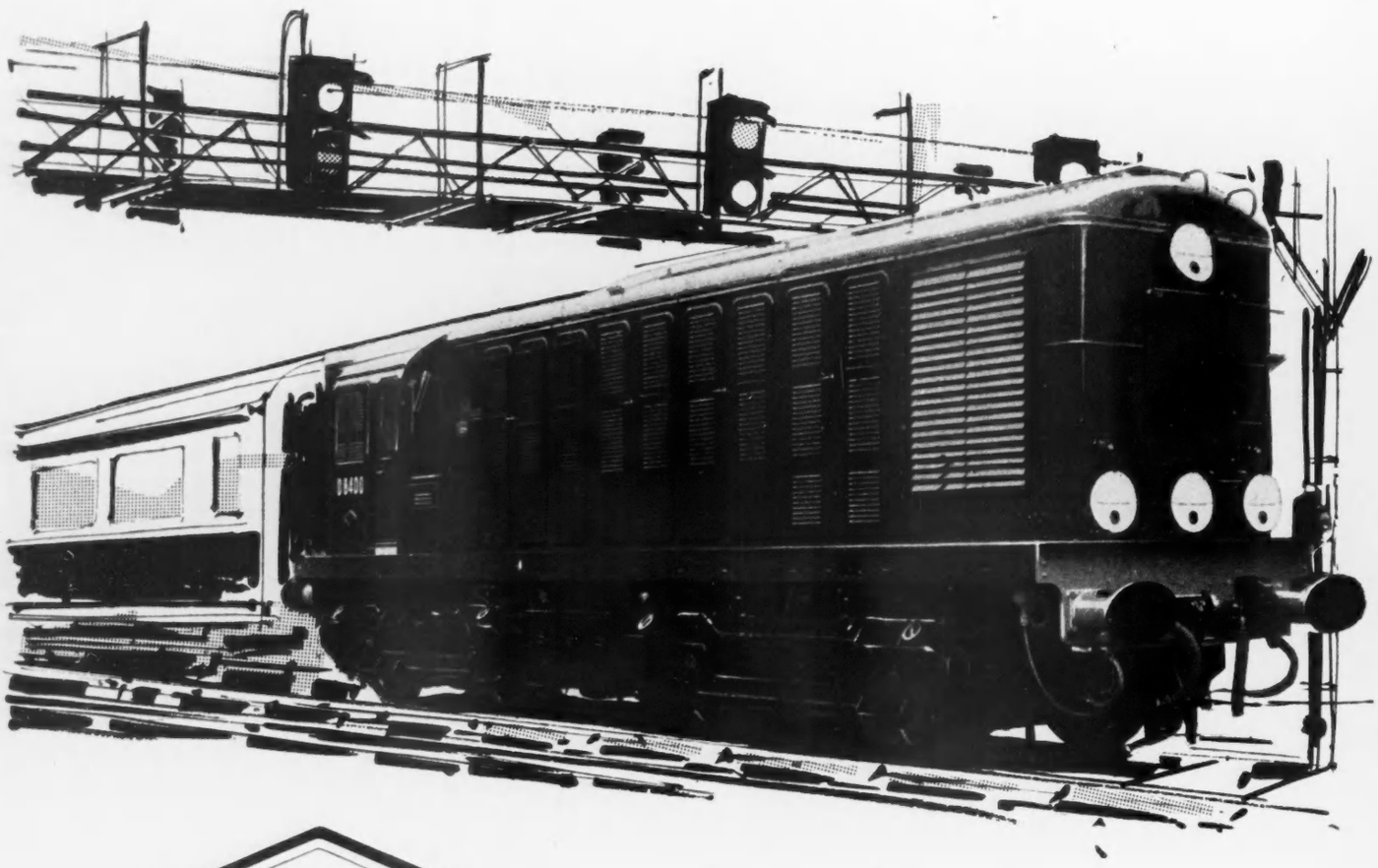

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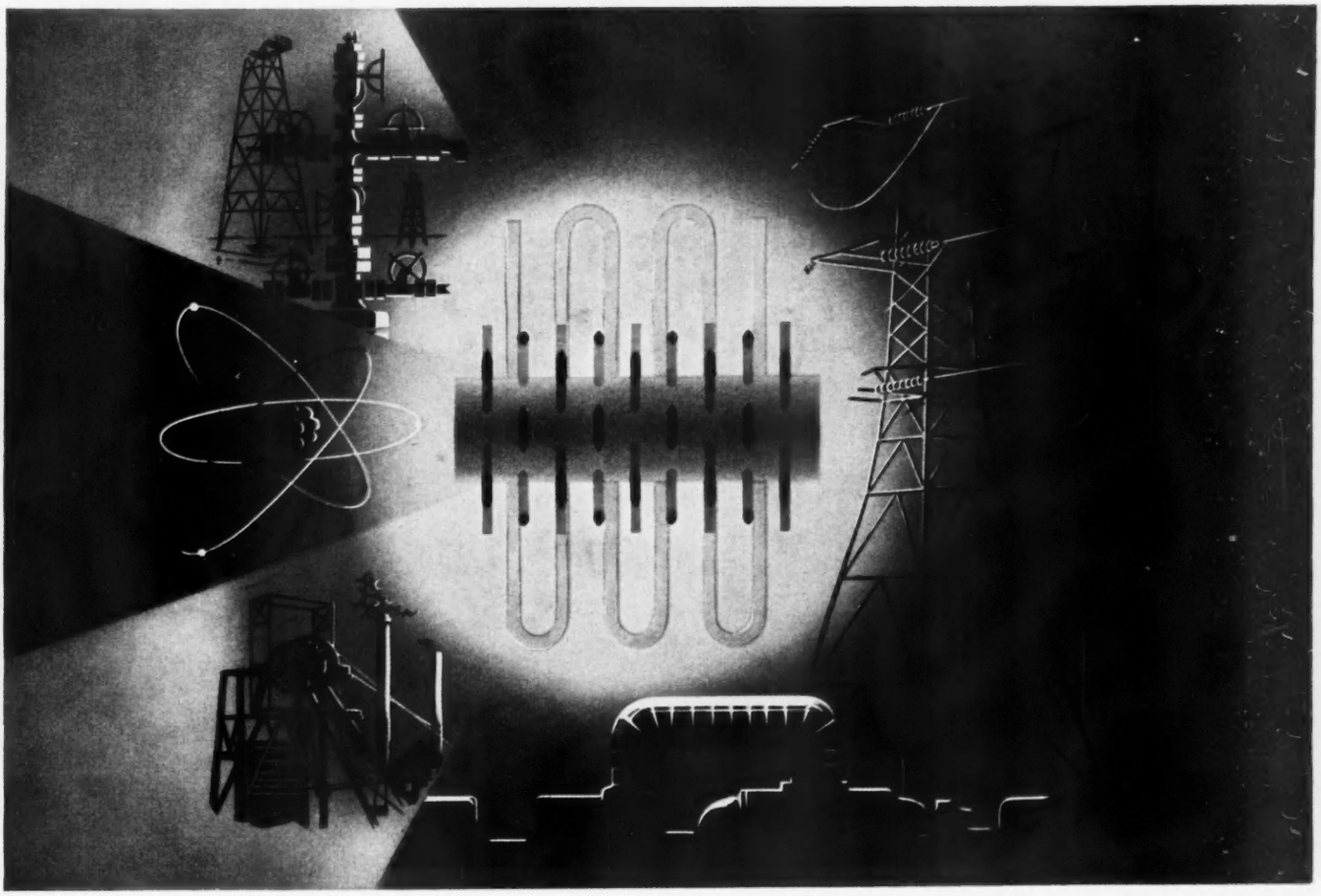

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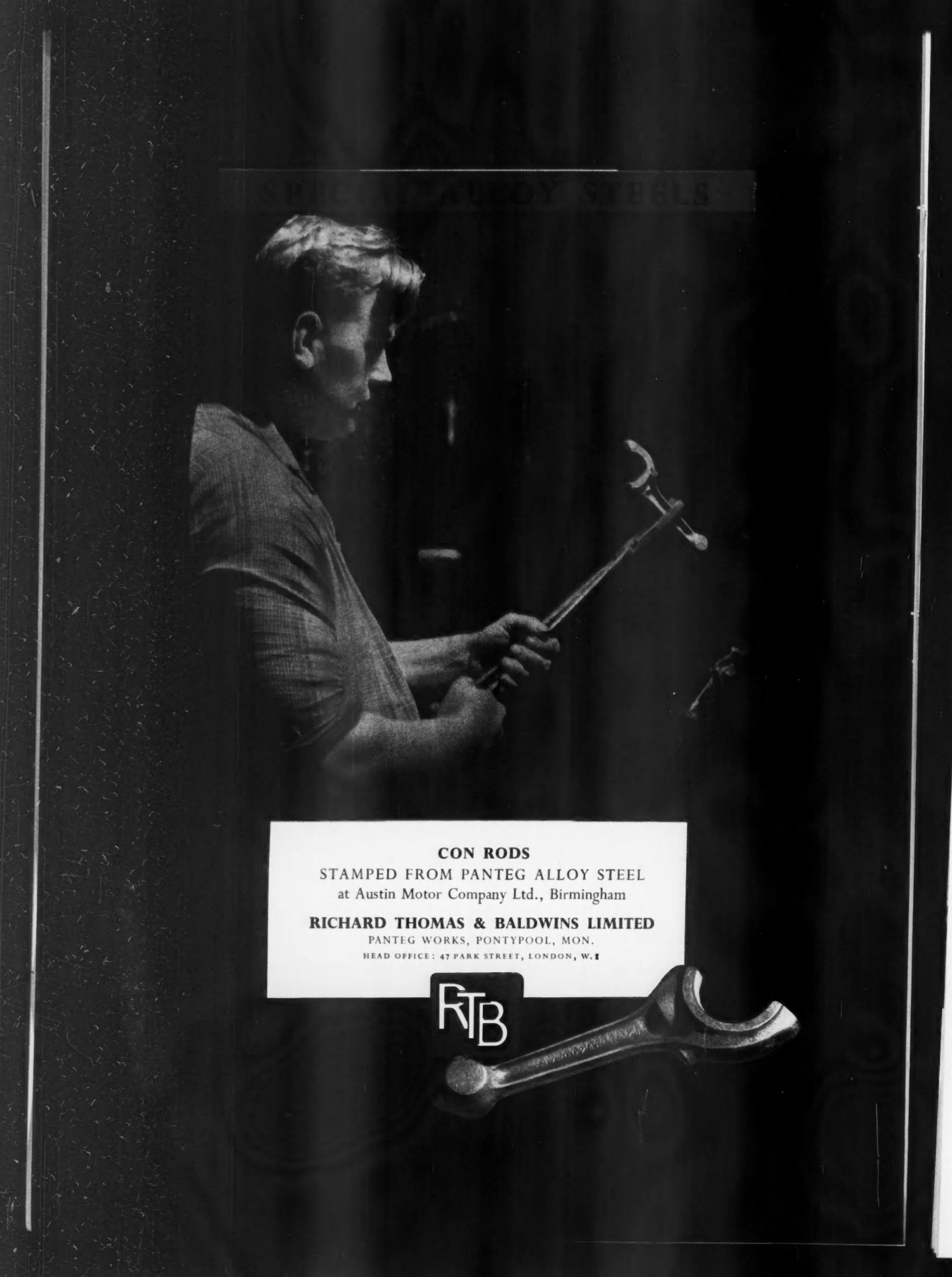
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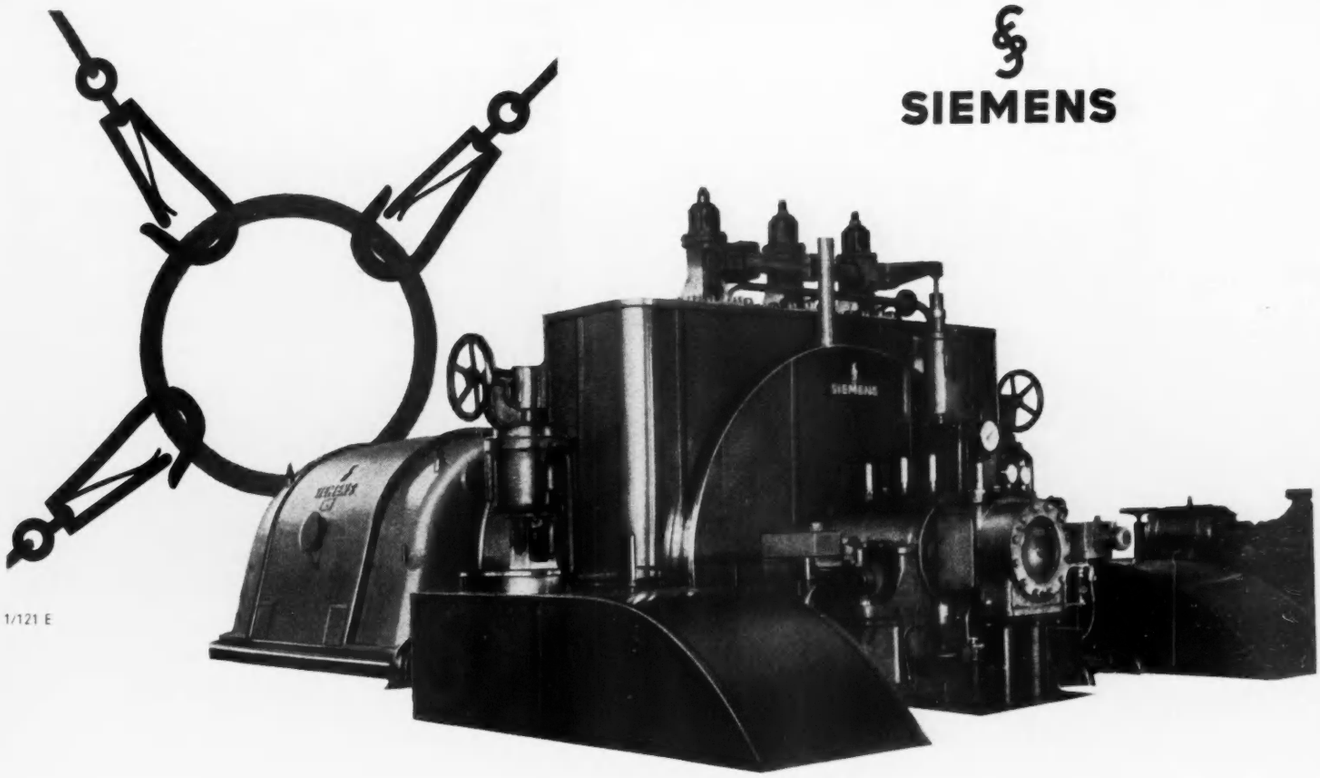

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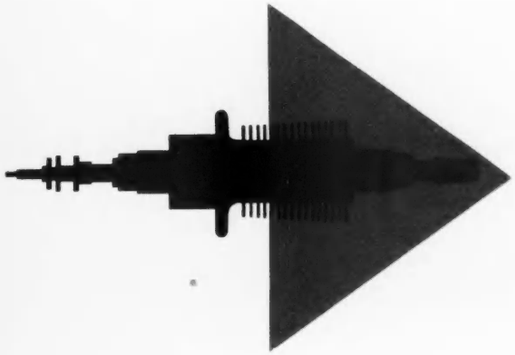

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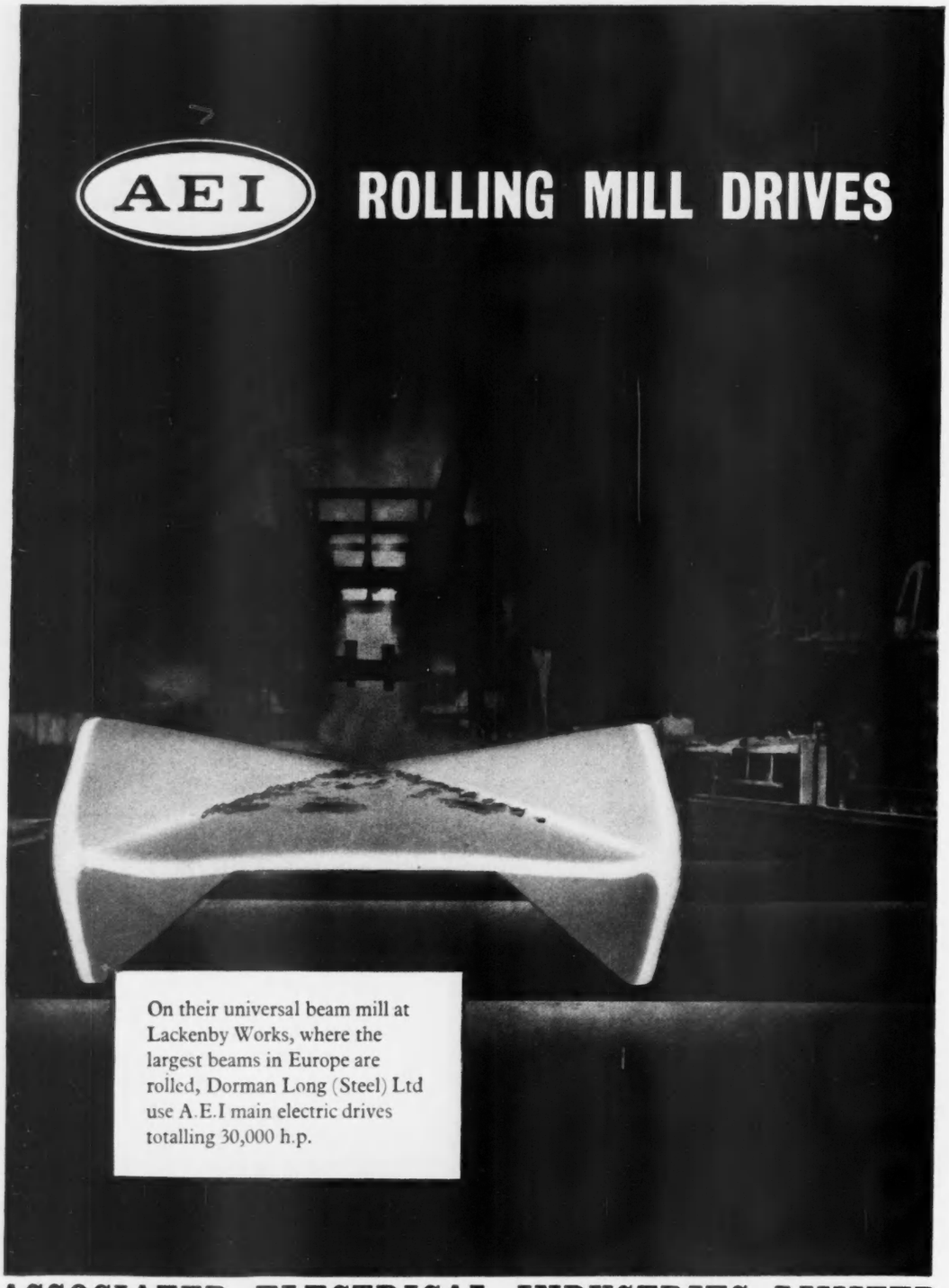

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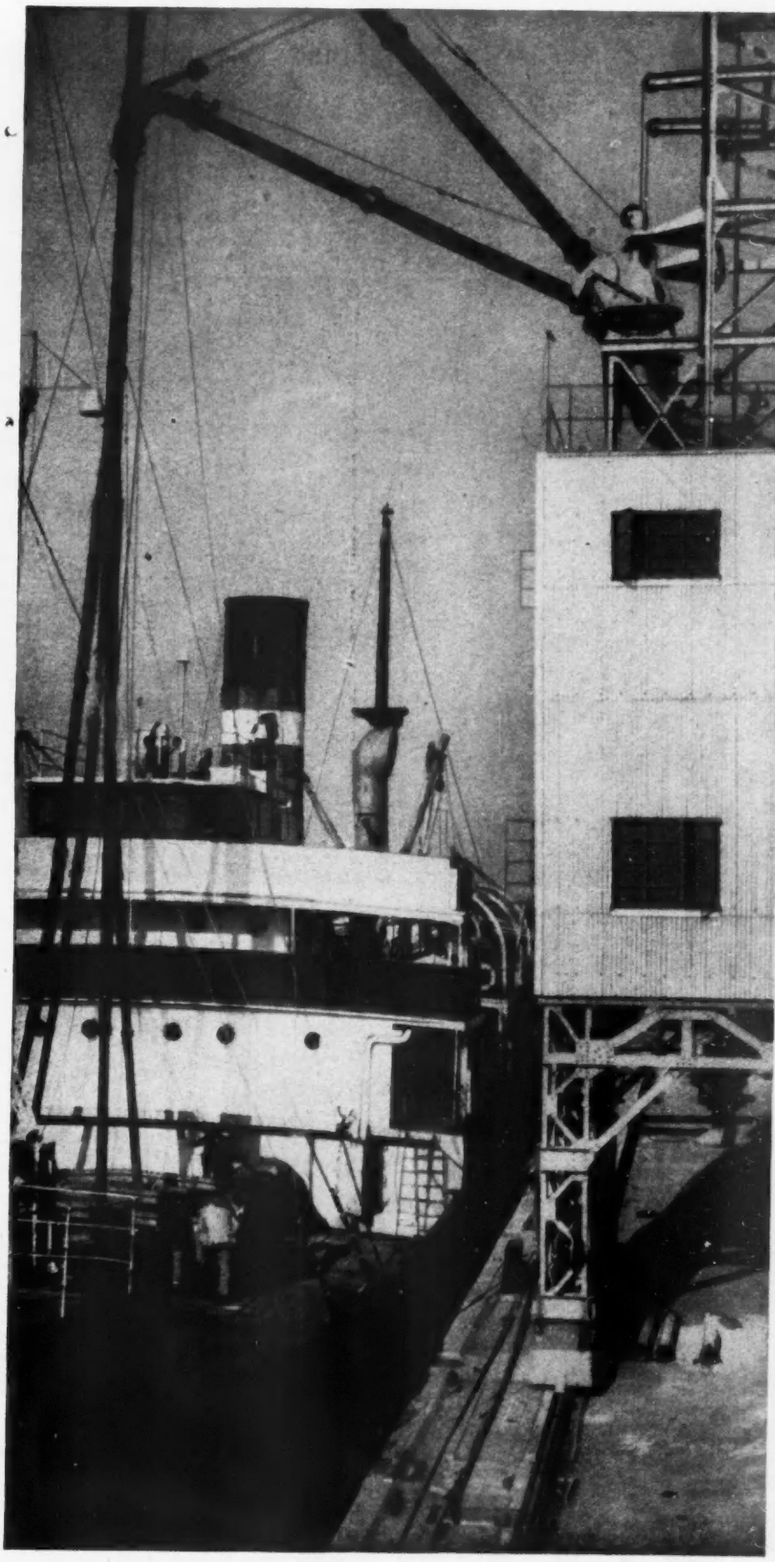

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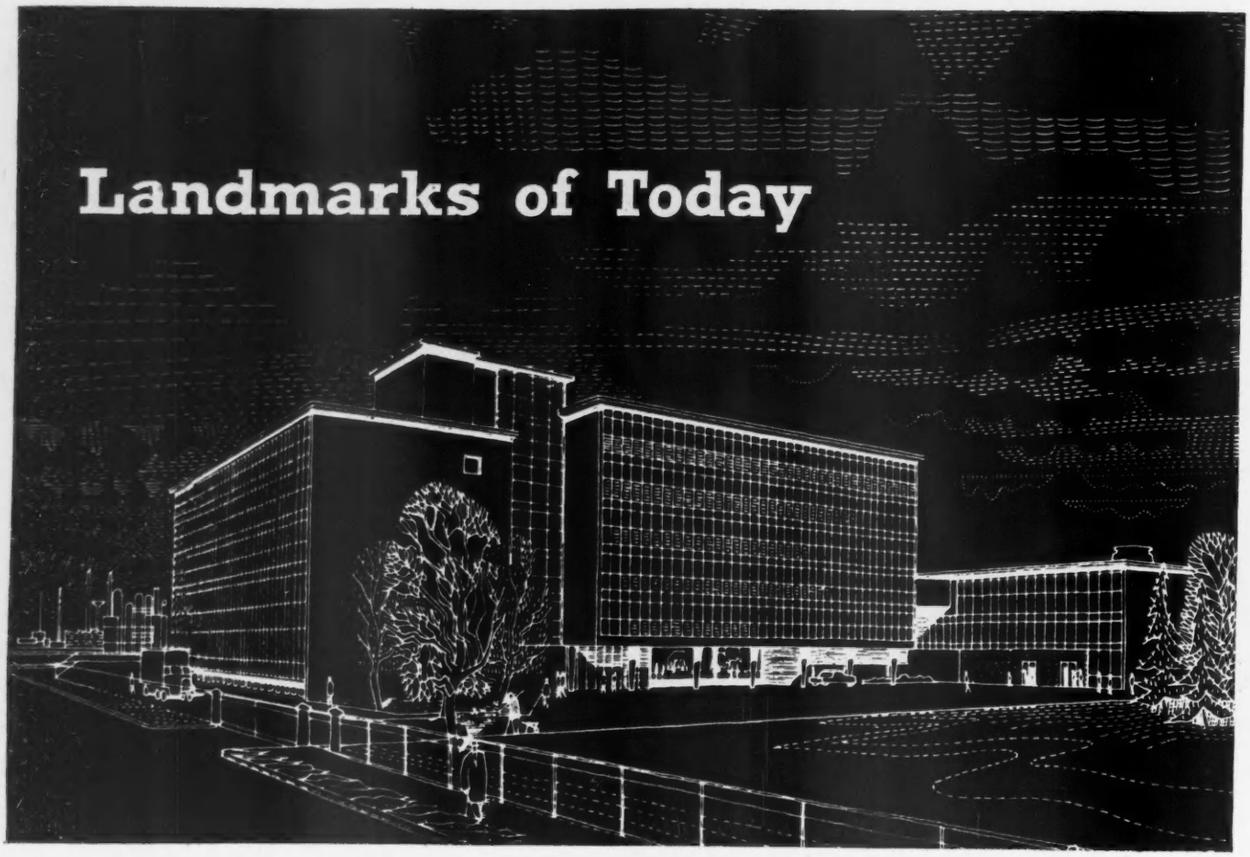

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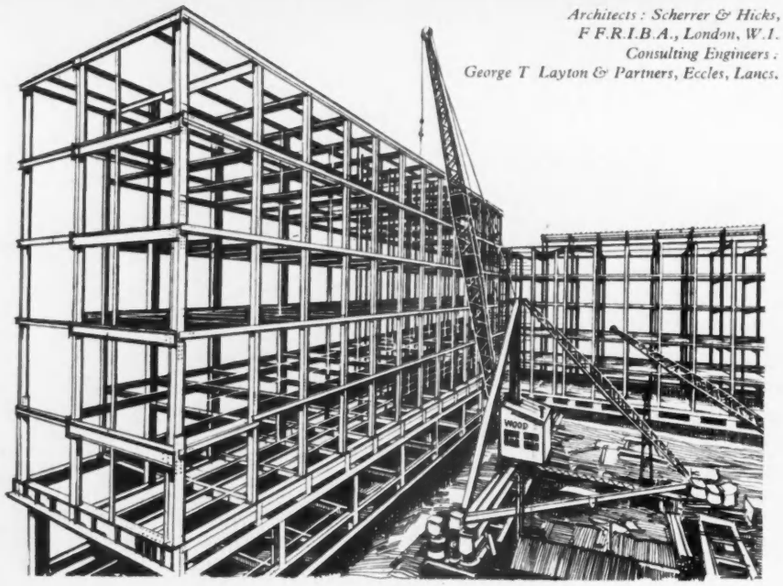

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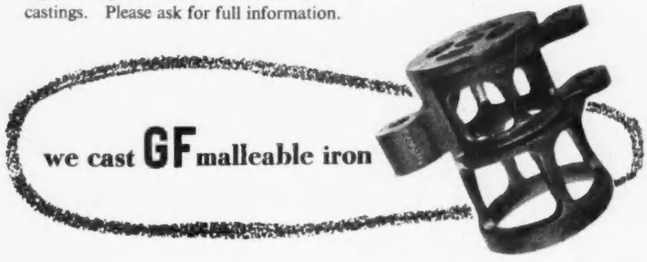

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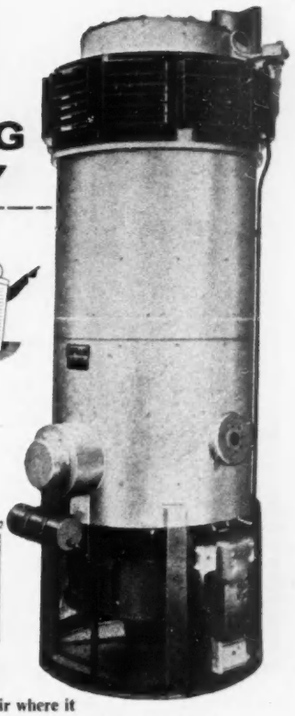

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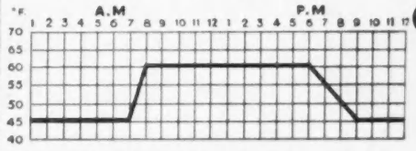

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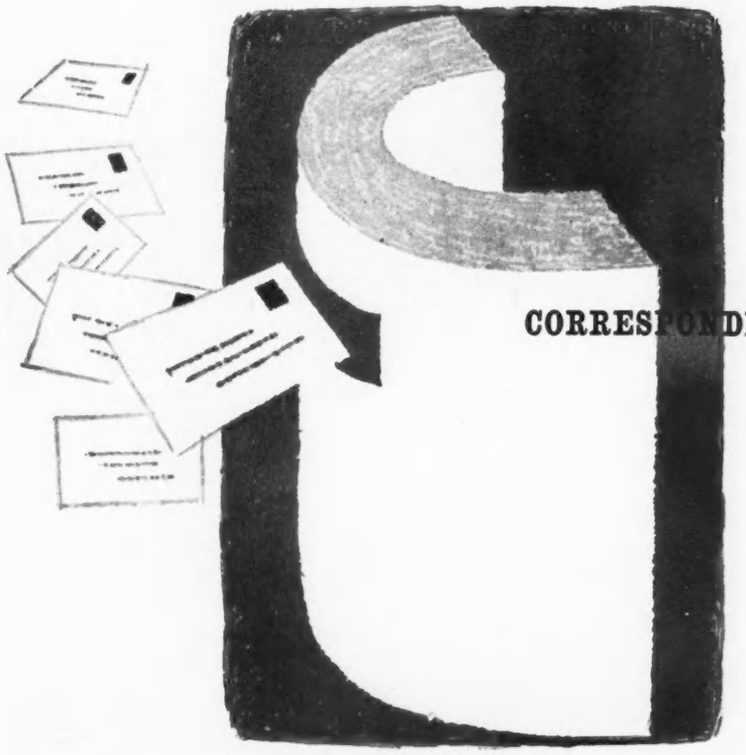

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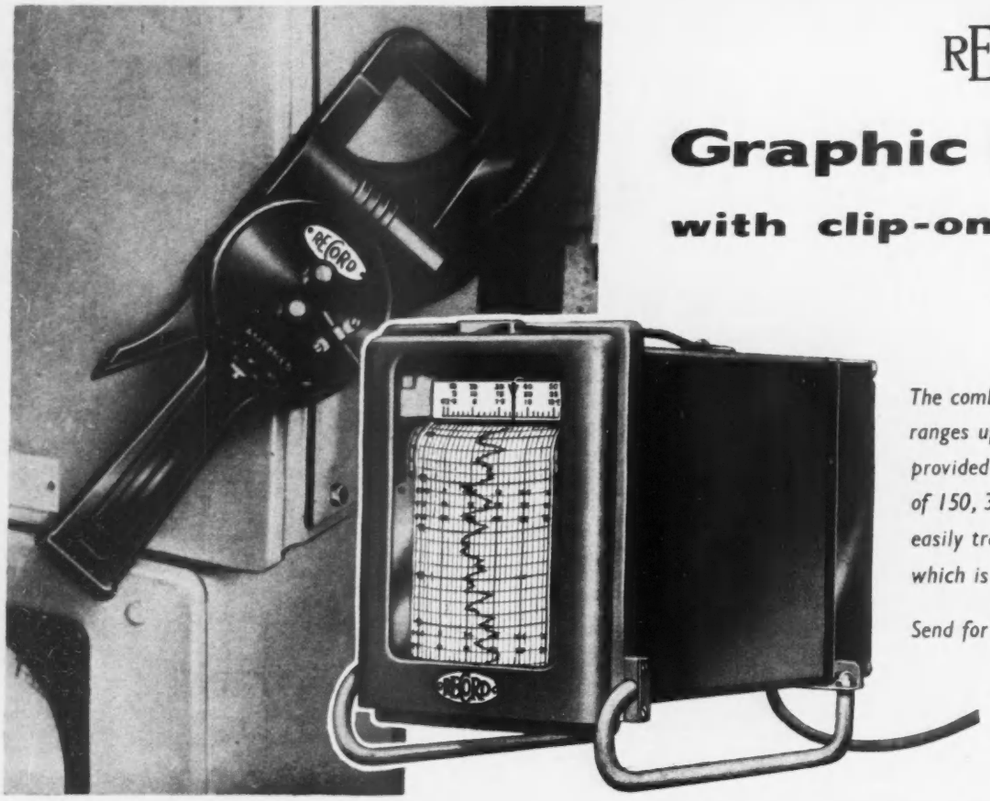

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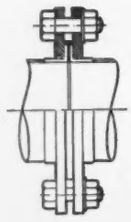

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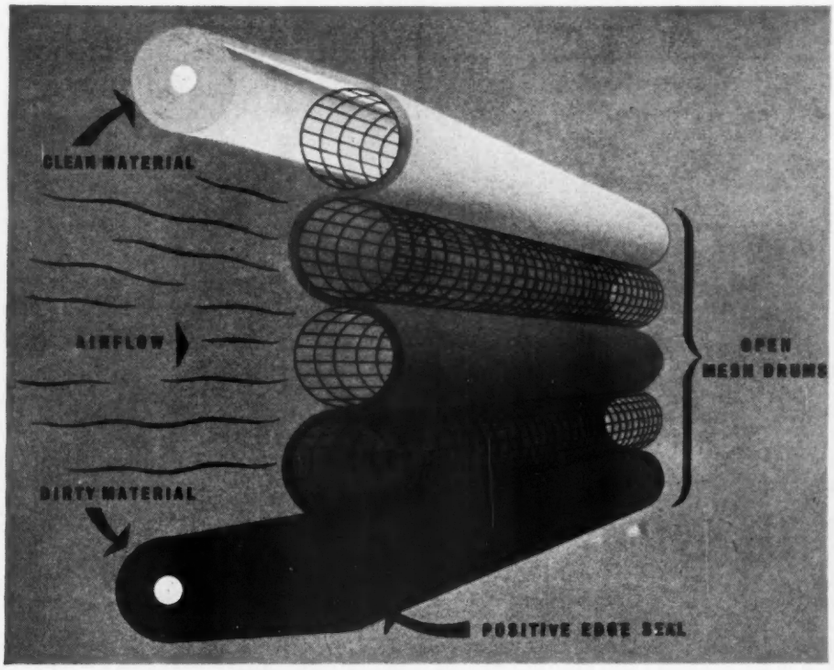

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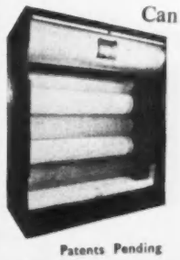

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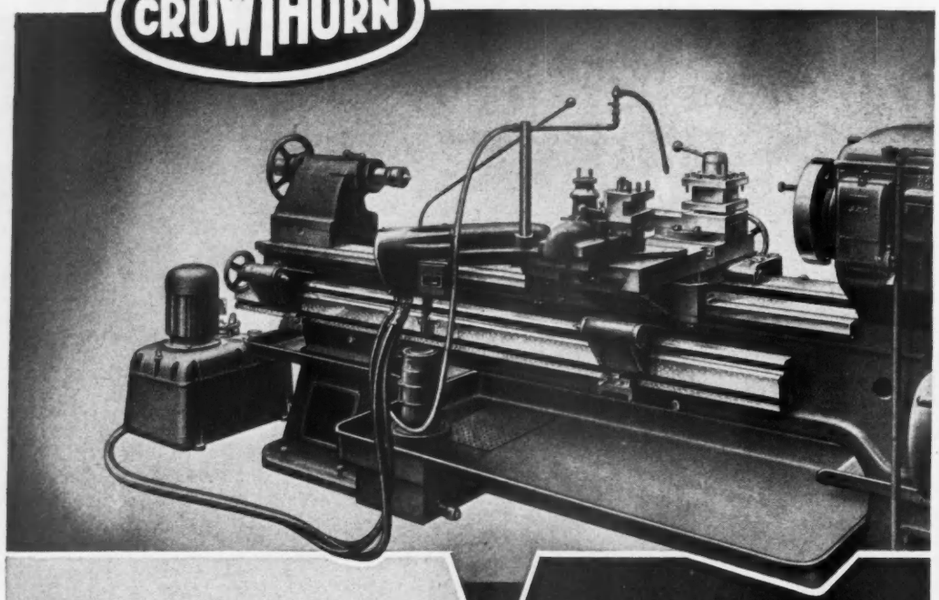

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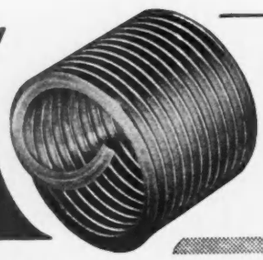

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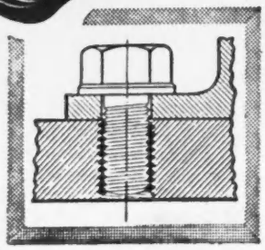

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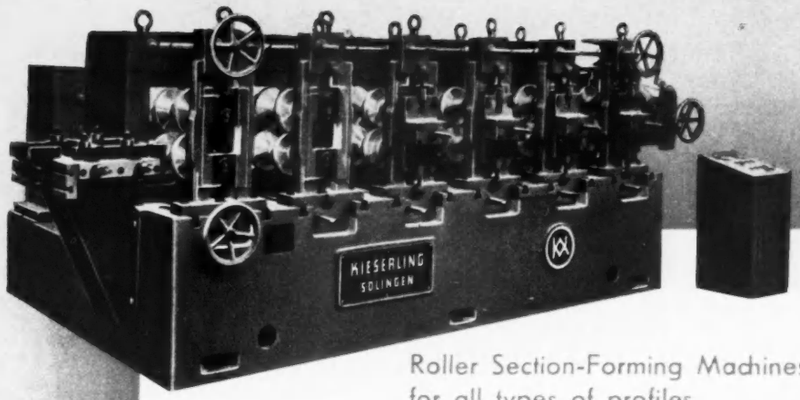

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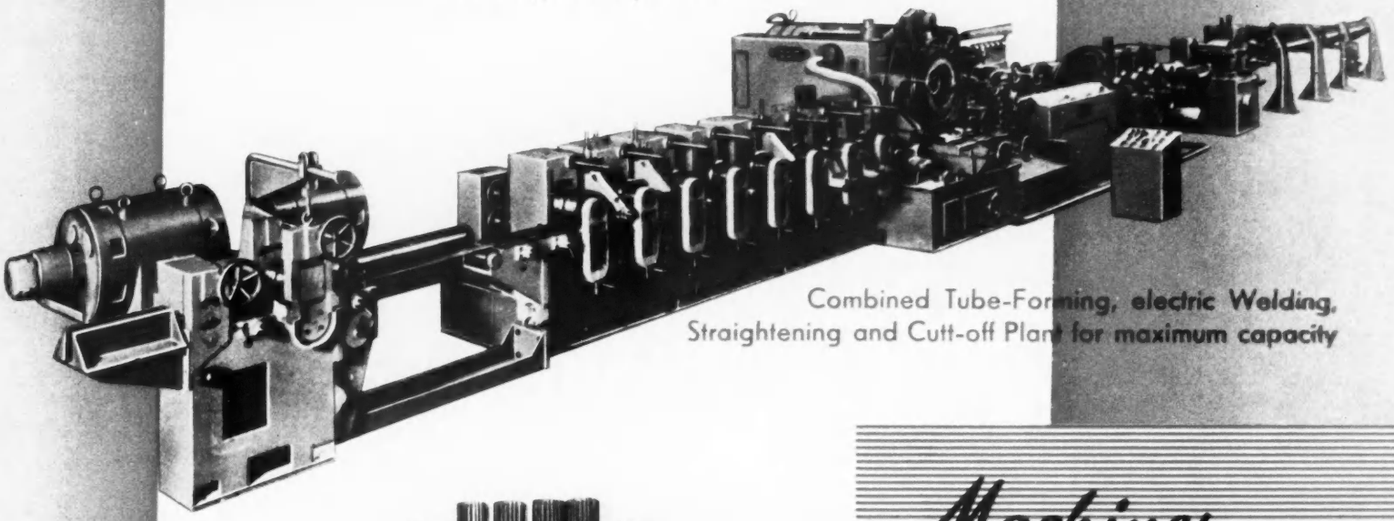

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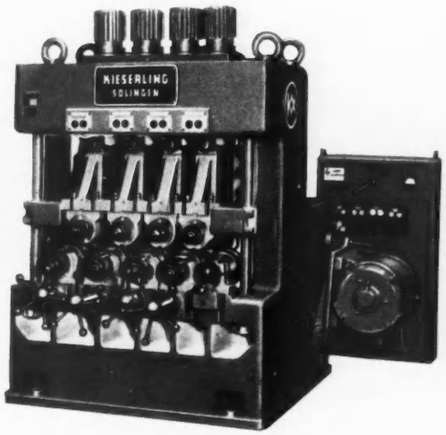

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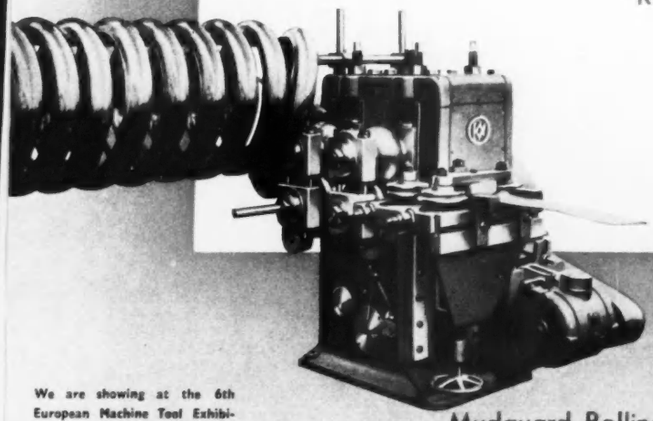

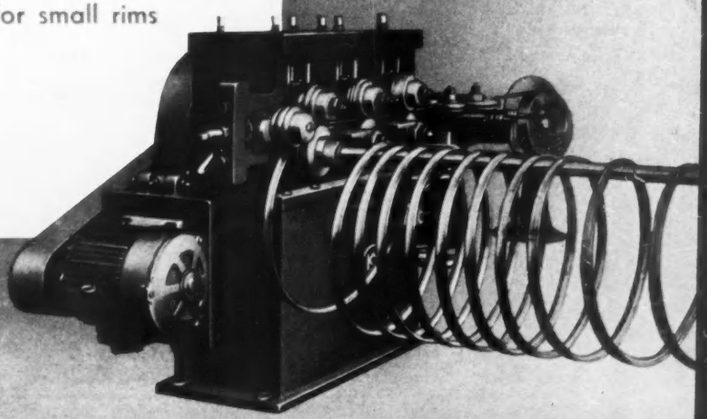

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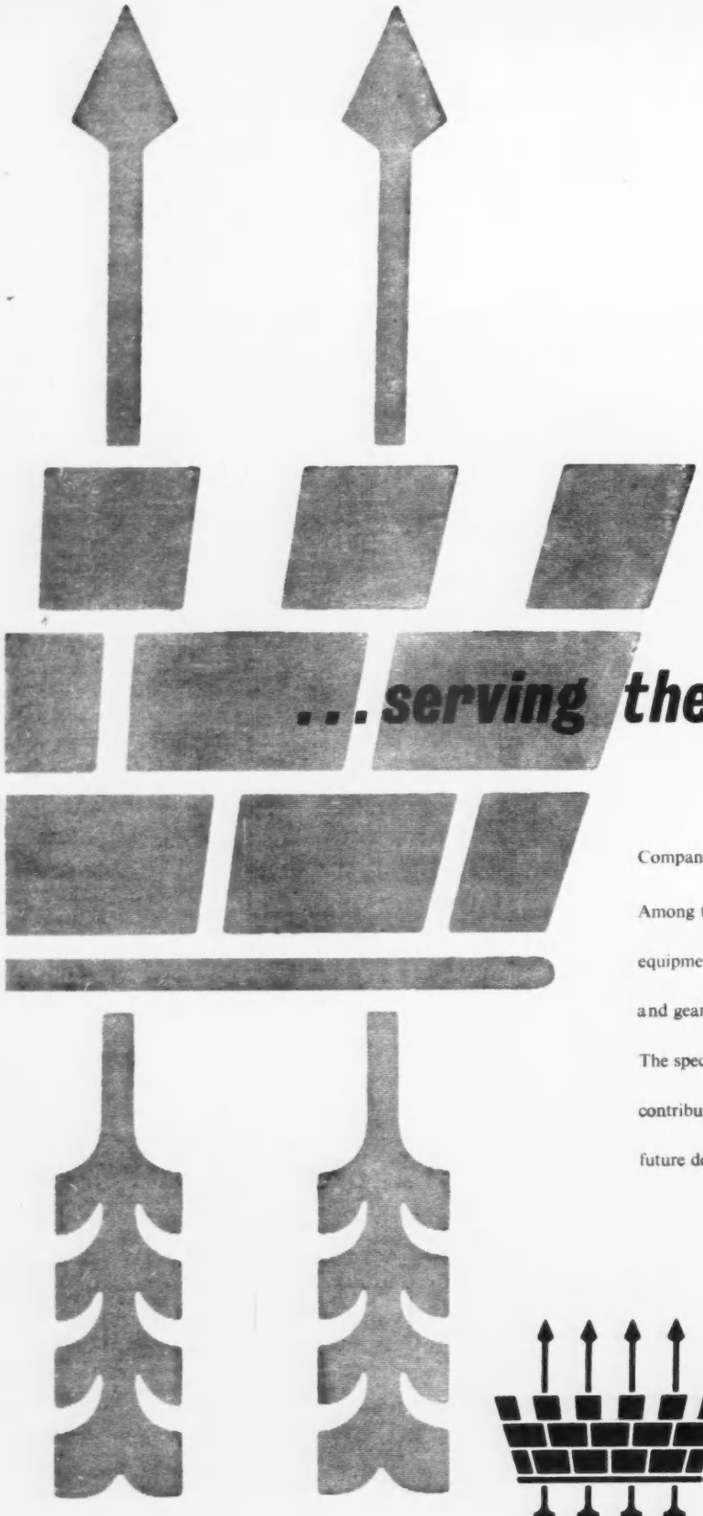

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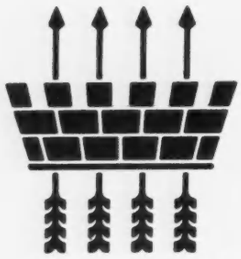

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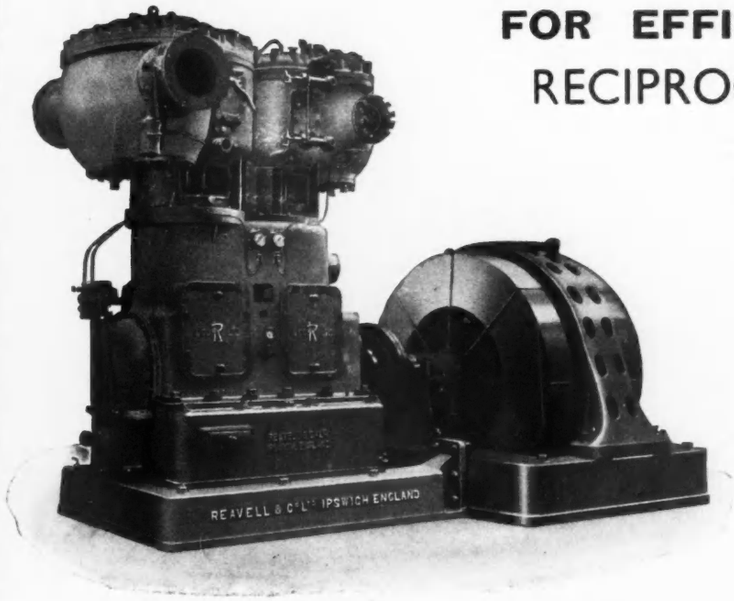

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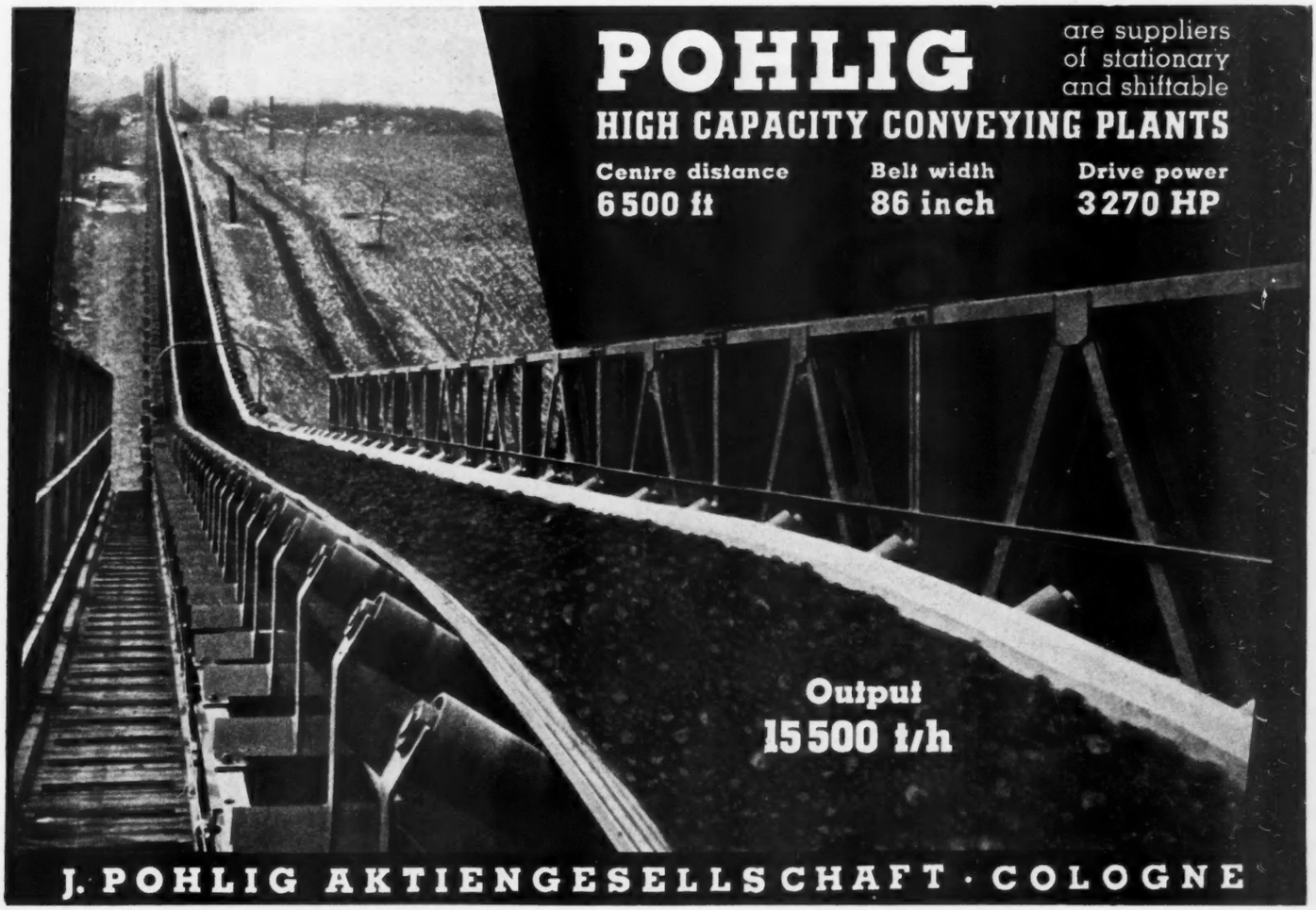

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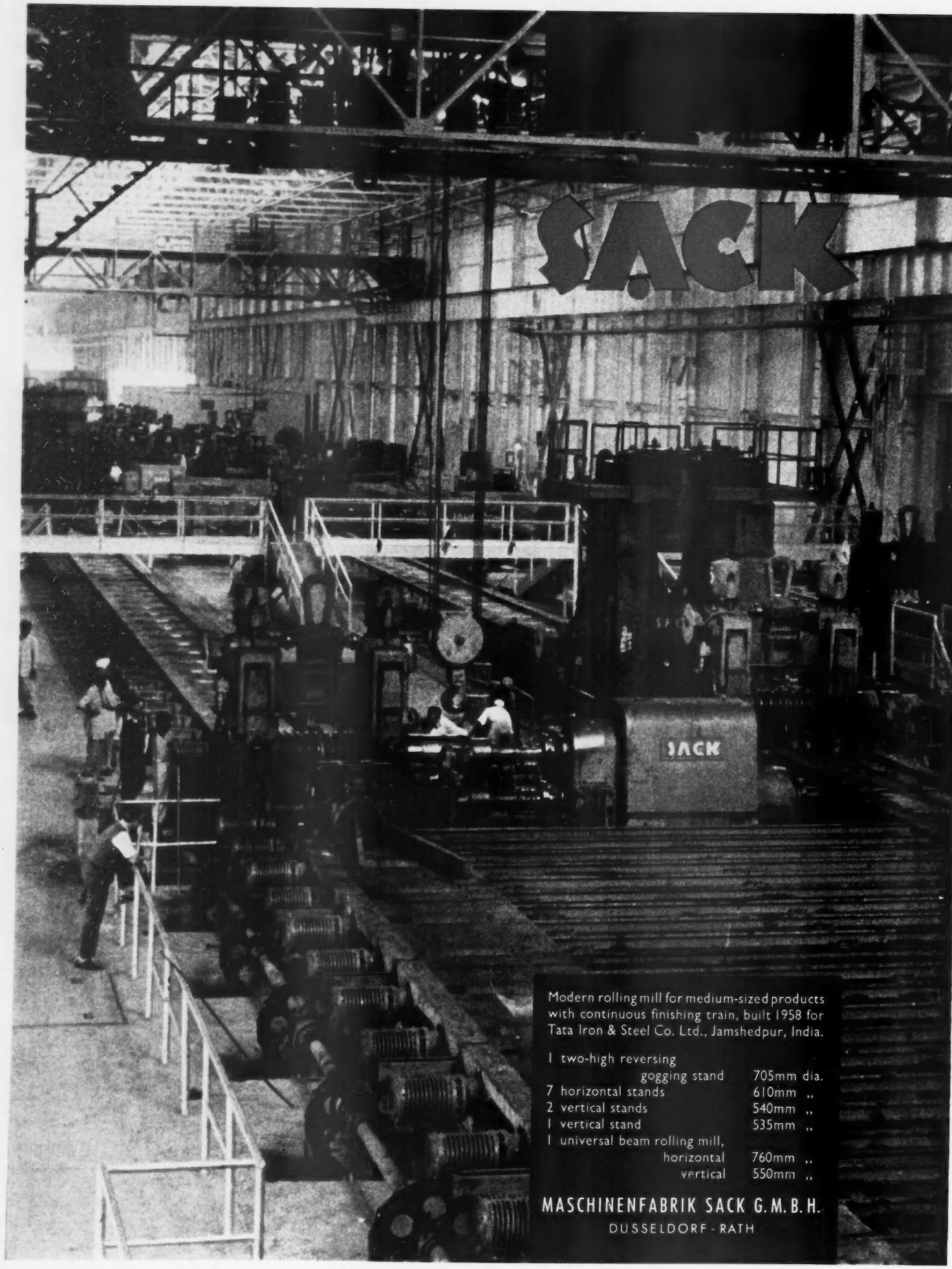

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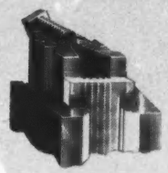

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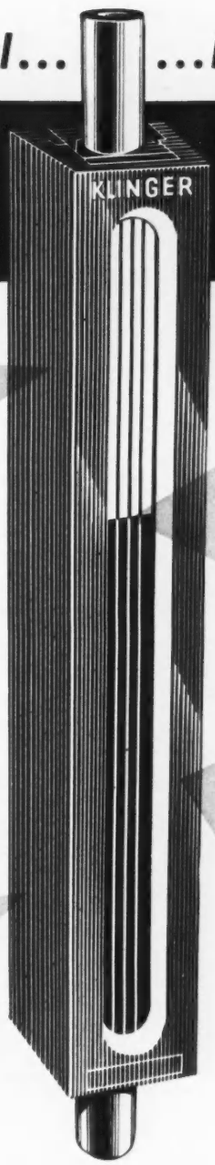

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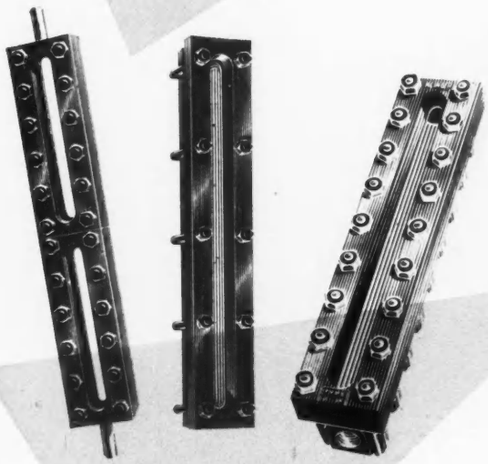

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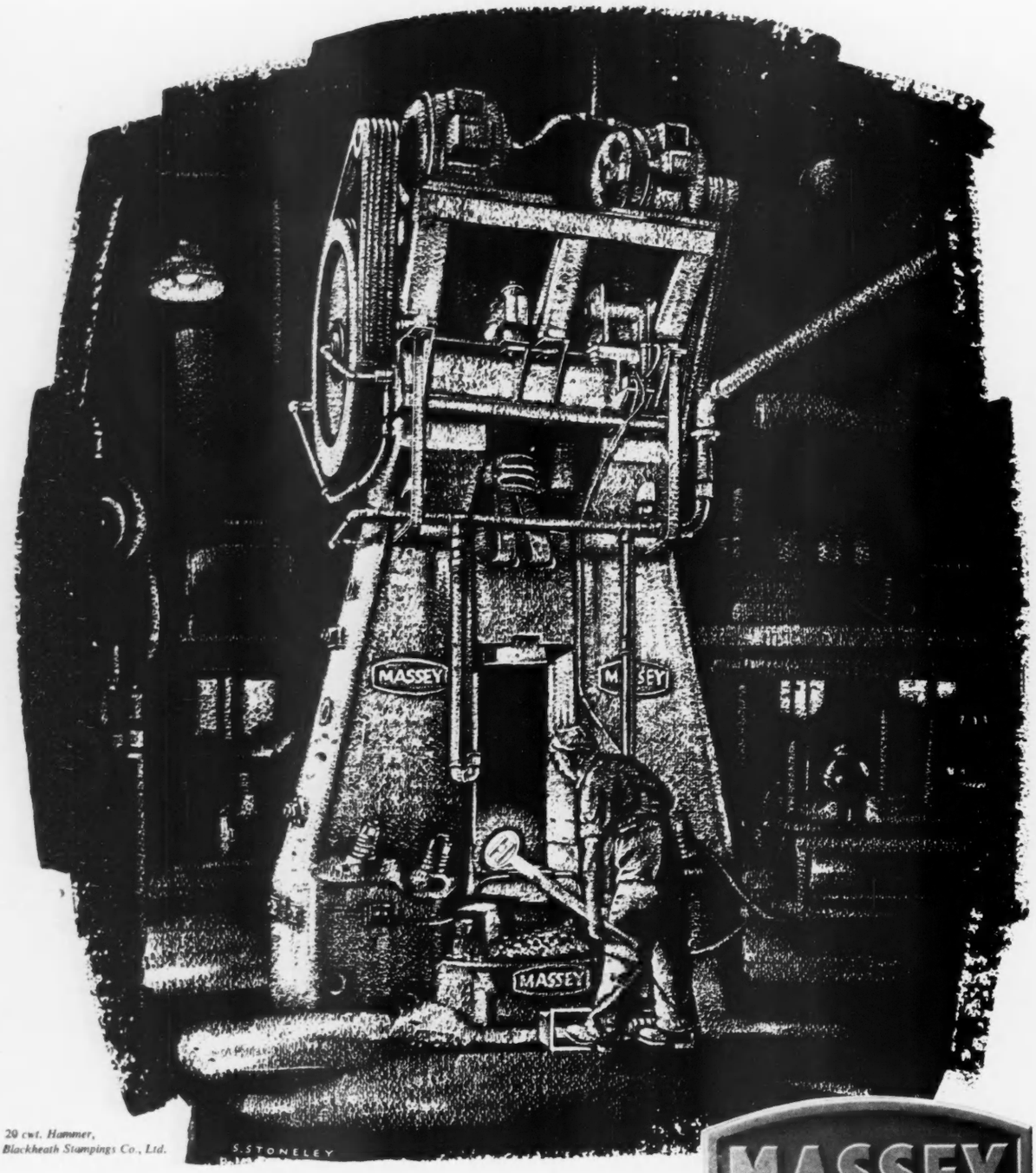

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Pusher Tug 'GONGOLA'

This Pusher Tug and a Train of eight close coupled barges was constructed by Yarrow to the order of the United Africa Company, for service on the Niger and Benue Rivers, West Africa. Overall length of the complete unit 630 feet, beam 66 feet, loaded displacement 4,650 tons.

YARROW

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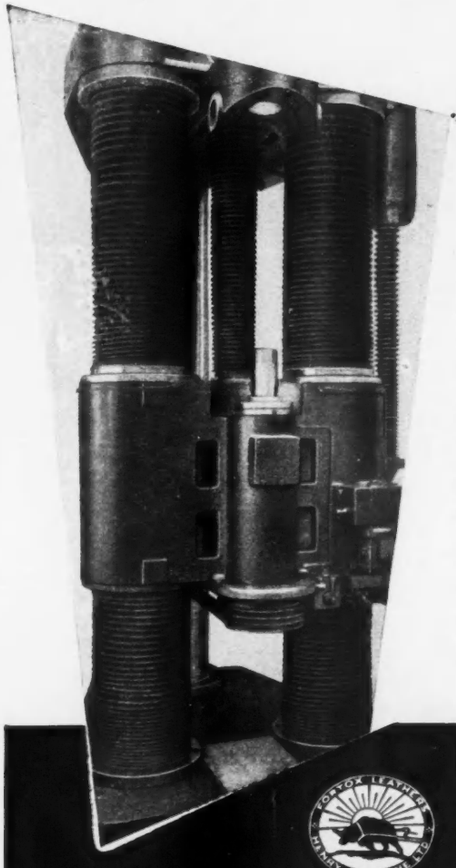

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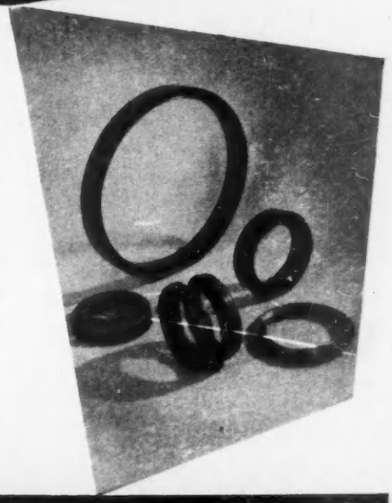

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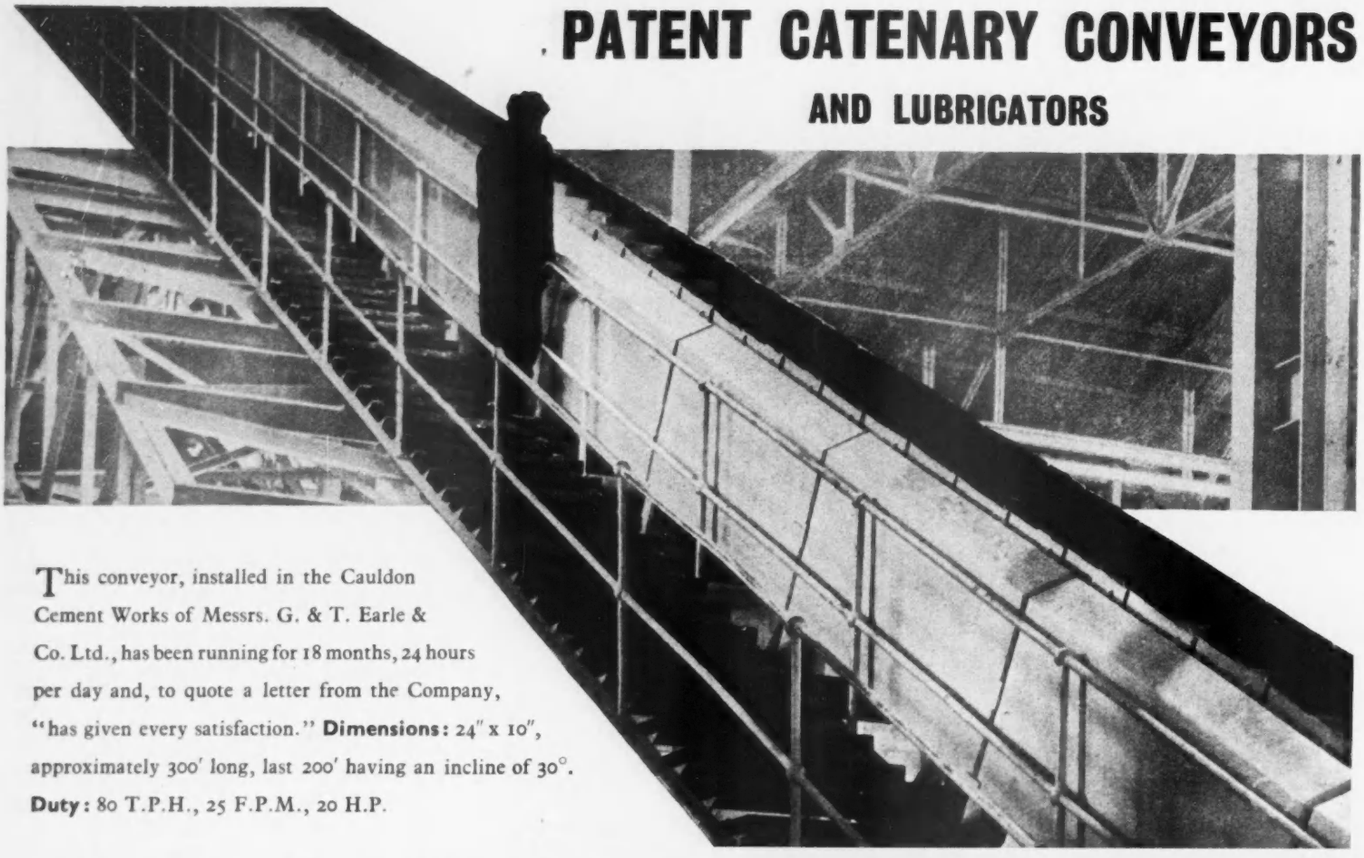
PATENT CATENARY CONVEYORS

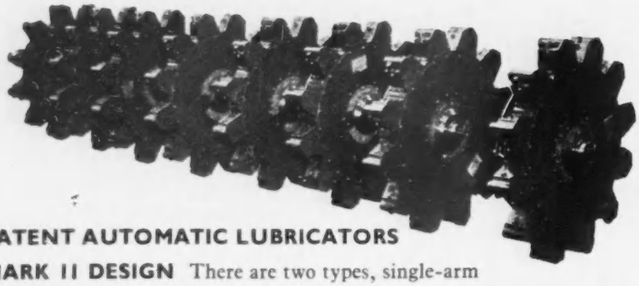
AND LUBRICATORS

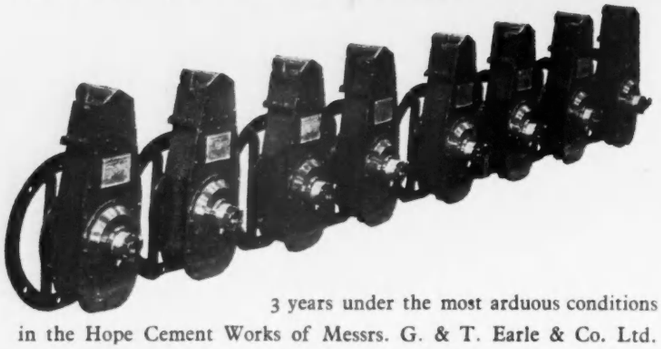


This conveyor, installed in the Cauldon Cement Works of Messrs. G. & T. Earle & Co. Ltd., has been running for 18 months, 24 hours per day and, to quote a letter from the Company, "has given every satisfaction." **Dimensions:** 24" x 10", approximately 300' long, last 200' having an incline of 30°. **Duty:** 80 T.P.H., 25 F.P.M., 20 H.P.

This conveyor, fitted with our automatic chain lubricators, is installed in the Rodmell Cement Works of Messrs. Associated Portland Cement Co. Ltd. and has been running for 9 months, 24 hours per day. Their Works Manager has expressed his complete satisfaction with performance of conveyor and lubricators. **Dimensions:** 18" x 6" x 45 T.P.H.

An 18" x 10" x 450' centres x 100 T.P.H. conveyor has since been supplied to Messrs. Associated Portland Cement Co. Ltd., for White's South African Portland Cement Co. Ltd. Lichtenburg Works and orders are on hand for two 40" x 10" catenary-type x 60' centres continuous elevators and two 18" x 5" conveyors for their Johnsons Works, to be fitted with our latest type of lubricator.





PATENT AUTOMATIC LUBRICATORS MARK II DESIGN There are two types, single-arm and multi-point, as illustrated, both of which give effective lubrication of chain and outboard rollers with the absolute minimum of attention and unskilled operation. Mark I prototype has been in operation for 3 years under the most arduous conditions in the Hope Cement Works of Messrs. G. & T. Earle & Co. Ltd. Both types have been exported in quantities for elevators and pig casting machines.

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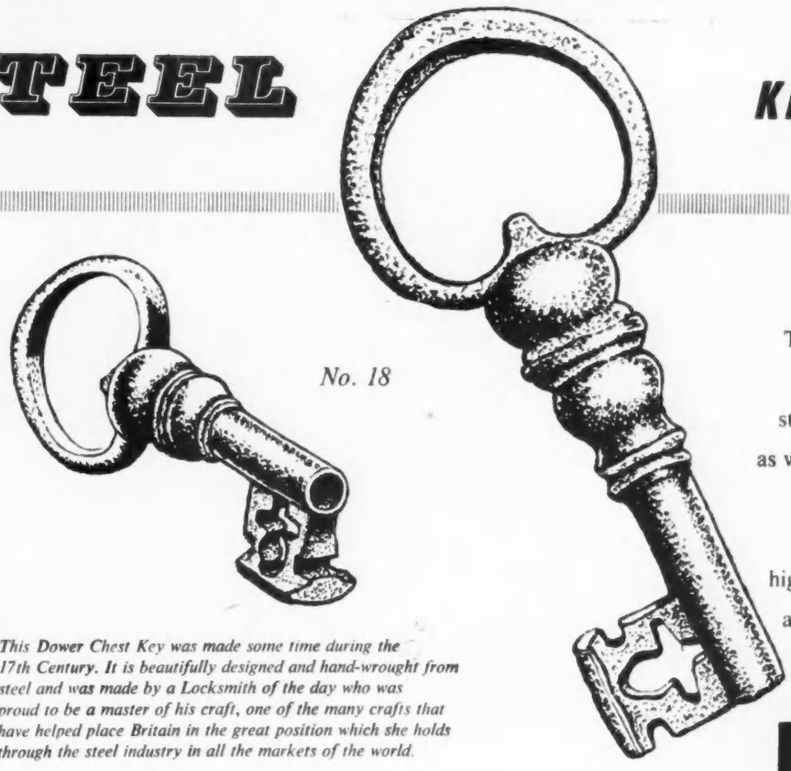
STEEL — KEY TO INDUSTRY



No. 18

This Dower Chest Key was made some time during the 17th Century. It is beautifully designed and hand-wrought from steel and was made by a Locksmith of the day who was proud to be a master of his craft, one of the many crafts that have helped place Britain in the great position which she holds through the steel industry in all the markets of the world.

The development of steel made possible the growth of civilisation itself. For steel is the key to the good things of life as well as to the necessities; as essential to the maker of the precision watch as to the bridge-builder. Hallamshire high-grade Alloy and Carbon steels serve a multitude of industries in many ways.

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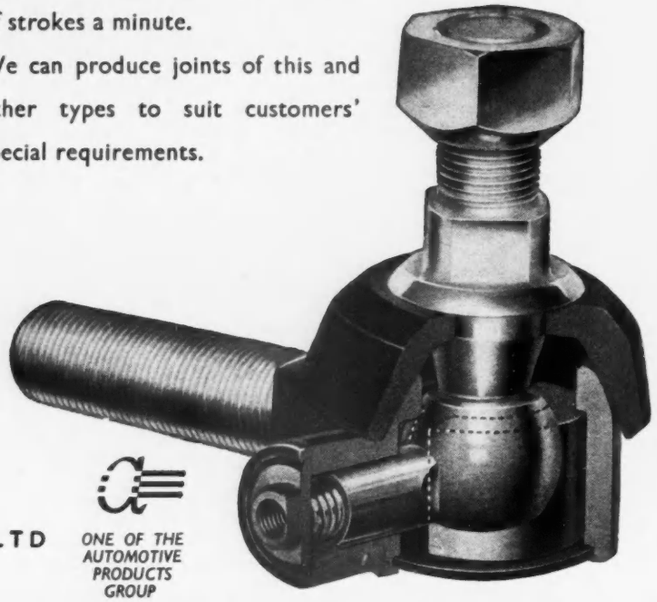
These joints are self-adjusting and are very well made from fine materials. Used extensively on steering connections for every class of road vehicle, they are also valuable in a great many applications in general engineering, where their use can often save specially-made joints and at the same time give an improved result by eliminating backlash.

A SPECIAL-PURPOSE JOINT

The illustration shows a 1" eccentric-type self-adjusting joint. This forms the crank-pin and big-end bearing of a crank operating the cutter bar of a mower, at many hundreds of strokes a minute.

We can produce joints of this and other types to suit customers' special requirements.



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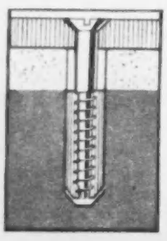

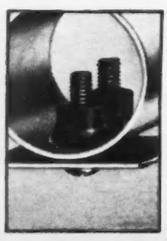
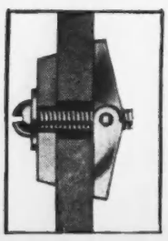
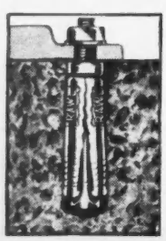

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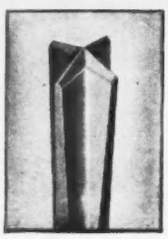

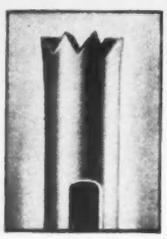

There's talk of Sykes in Paris

Present day engineering practice is becoming more and more complex with the result that the Production engineer has to rely to an increasing degree on specialist advice and assistance with his problems. The benefits of specialisation are evident in the Gear Cutting machines and tools displayed by Sykes at the 6th European Machine Tool Exhibition.

Sykes technicians and craftsmen are responsible for some striking new developments in precision machine tools for gear production. The five models, exhibited for the first time in Paris this year, reflect the current trend towards automation coupled with high production rates.

In this group are models for automatic loading of Internal and External helical gears, a fine pitch precision gear shaving machine with automatic cycle and a hopper feed; and a unique development of a horizontal gear generator equipped with magazine feed and automatic cycle which is tooled up to produce two different gears simultaneously.

If you have a problem connected with gear production, remember that Sykes Technical Advisory Service and service engineers are ready to help you. With an accumulated knowledge and technique gained in over 25 years of specialised research and development Sykes are well qualified to advise, and produce the answer, on any aspect of gear production.

Talk to SYKES about gear production

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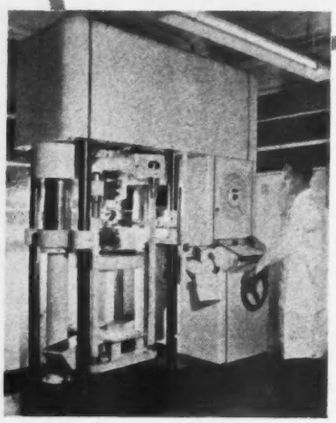
DENISON UNIVERSAL TESTING MACHINES

10-50 TONS CAPACITY



A Denison Model T42B Universal Testing Machine at the laboratories of John Holroyd & Co. Ltd., Holfos Works, Rochdale. Photograph shows the Patent Mechanical Extensometer being used.

These multi-capacity Self-Indicating Universal Testing Machines embody many outstanding features. The load is accurately measured through knife-edged weighing levers and all controls are conveniently grouped so that operators find these machines a pleasure to handle.

The New 28PH Autographic Stress-Strain Recorder is a considerable advance on the general methods for the production of graphs showing the behaviour of the specimen under test. The high magnification Patent Mechanical Extensometer operates direct from the specimen.

No. 36 Load Pacing Disc with an infinitely variable range of speeds on any capacity range can be fitted where it is desired to load at a constant rate.

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The Extra large suction port of these Mirrlees Imo Pumps ensures the easy flow of viscous fluids into the pump. They can handle such fluids as Viscose, Grease, etc., without pulsation or emulsification, thus perpetuating all the virtues of the Mirrlees Imo Pumps which are available for a range of designs for most oils. Fuller information will be sent on request.

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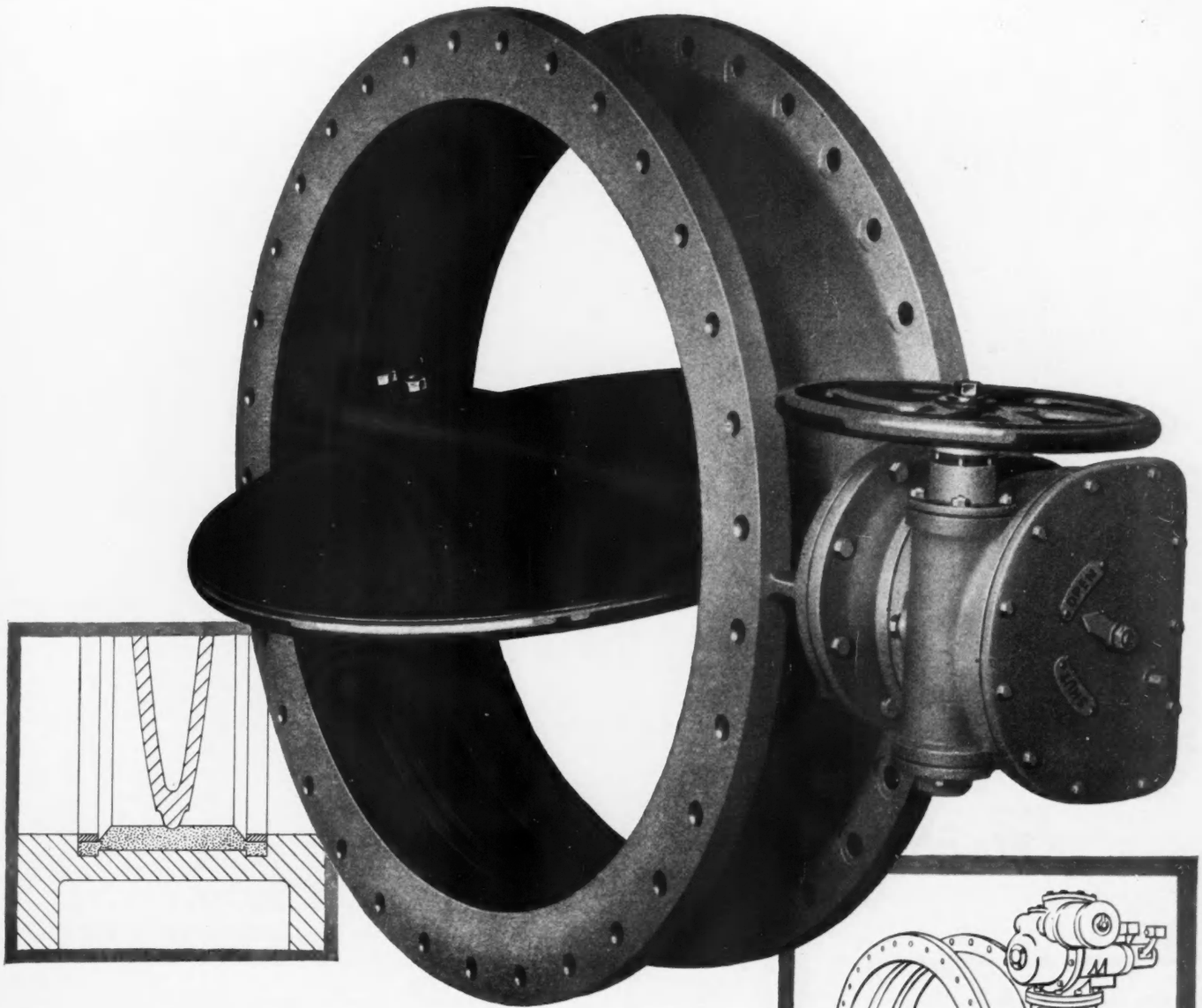

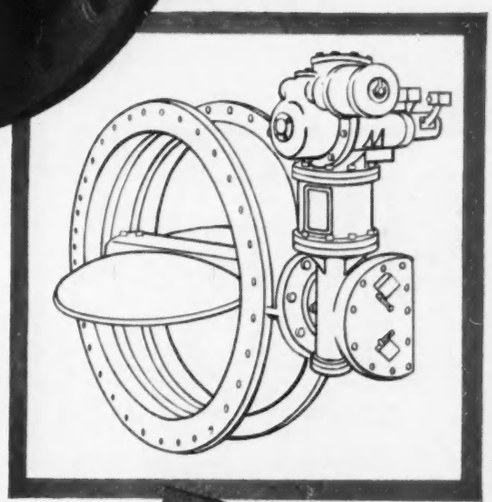

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Combining positive drop-tight-shut-off with the natural advantages of the Butterfly principle, the Blakeborough Rubber Seated type is an attractive proposition for a wide variety of moderate-pressure services, of which condenser cooling water is a notable example.
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The Departmental Store of Anderson & McAuley Ltd. is the proud possessor of Belfast's first escalator. It was installed, of course, by J. & E. Hall. Decorative features of the balustrade casings include aluminium alloy deckings and mouldings, left natural satin finish, with the inner panels faced with Formica—Opaline Green for one escalator and Buff Linnette for the other.

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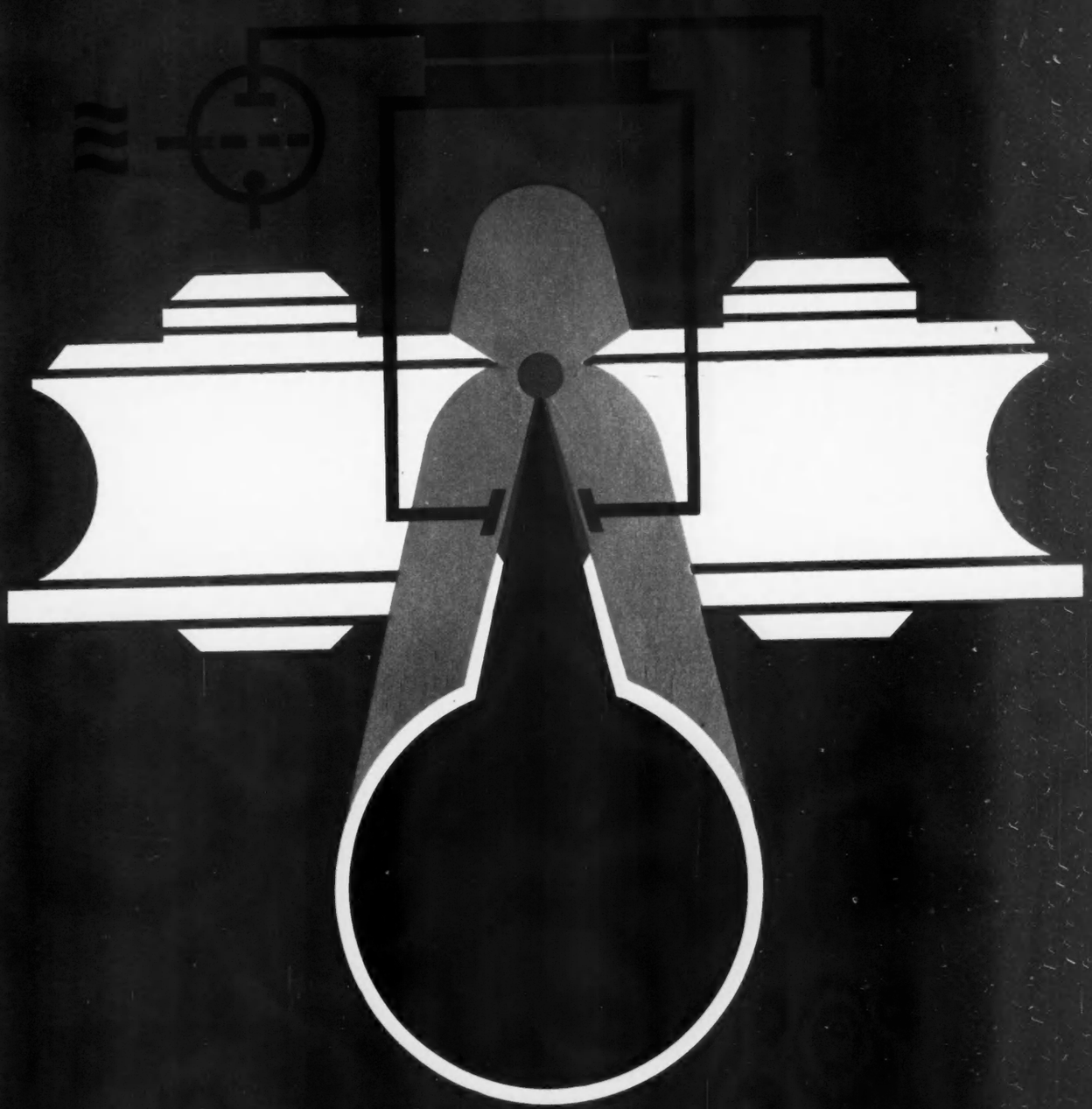

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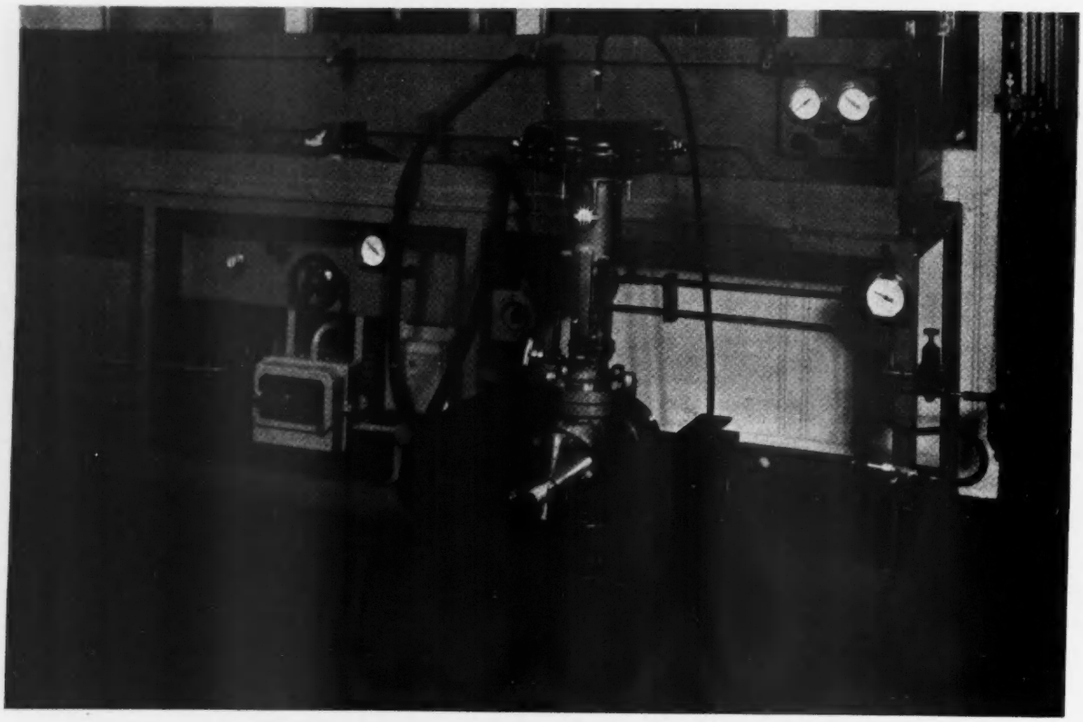

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CONTROL VALVES & associated equipment

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Cockburns Ltd., and their Associated Companies in the United Kingdom, Holland and France are now manufacturing Super 70 series Control Valves, Regulators, Liquid Level Controllers, Safety Lead Flanges, under licence from Black, Sivalls & Bryson, Inc., Kansas City, U.S.A.

The Super 70 series offers a new standard in precise control and regulation, with pneumatic or hydraulic operation. Flow co-efficients have been thoroughly laboratory tested for the complete range of valves. Super 70 valves have demonstrated their superior performance characteristics in oil refineries, chemical plants and power stations all over the world.

A 4" Super 70 control valve on test at our works. This valve is one of a consignment for Hassi Massaud Oilfields, French Sahara.

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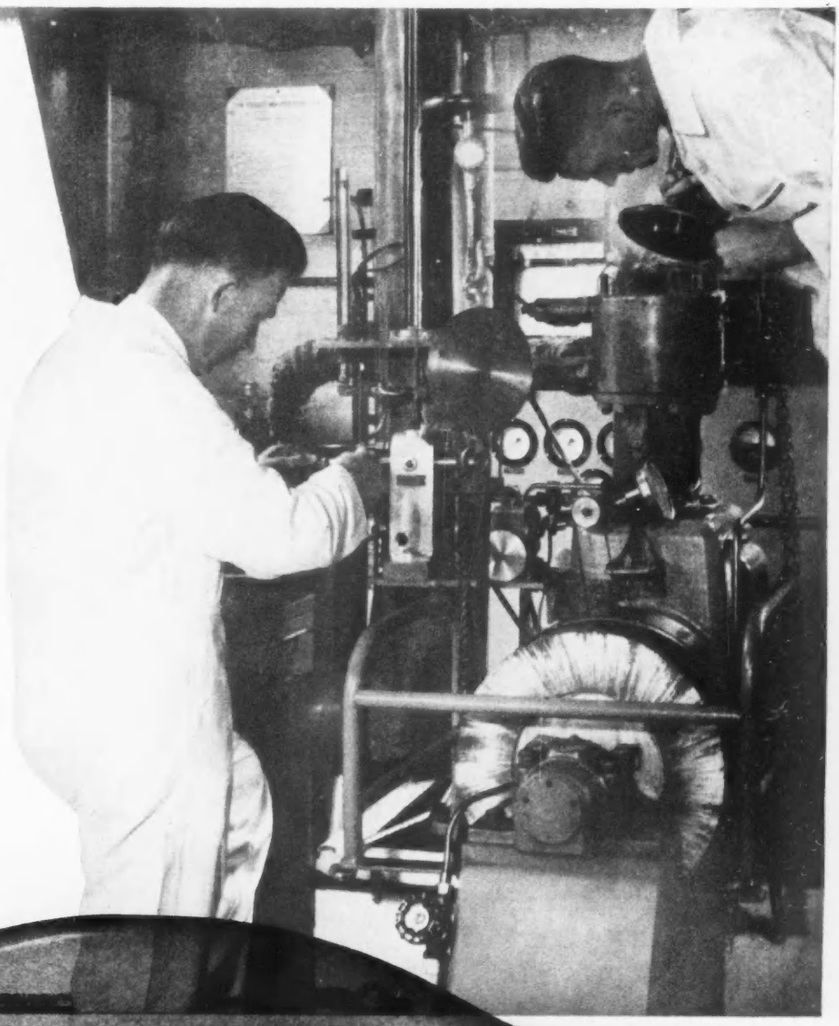

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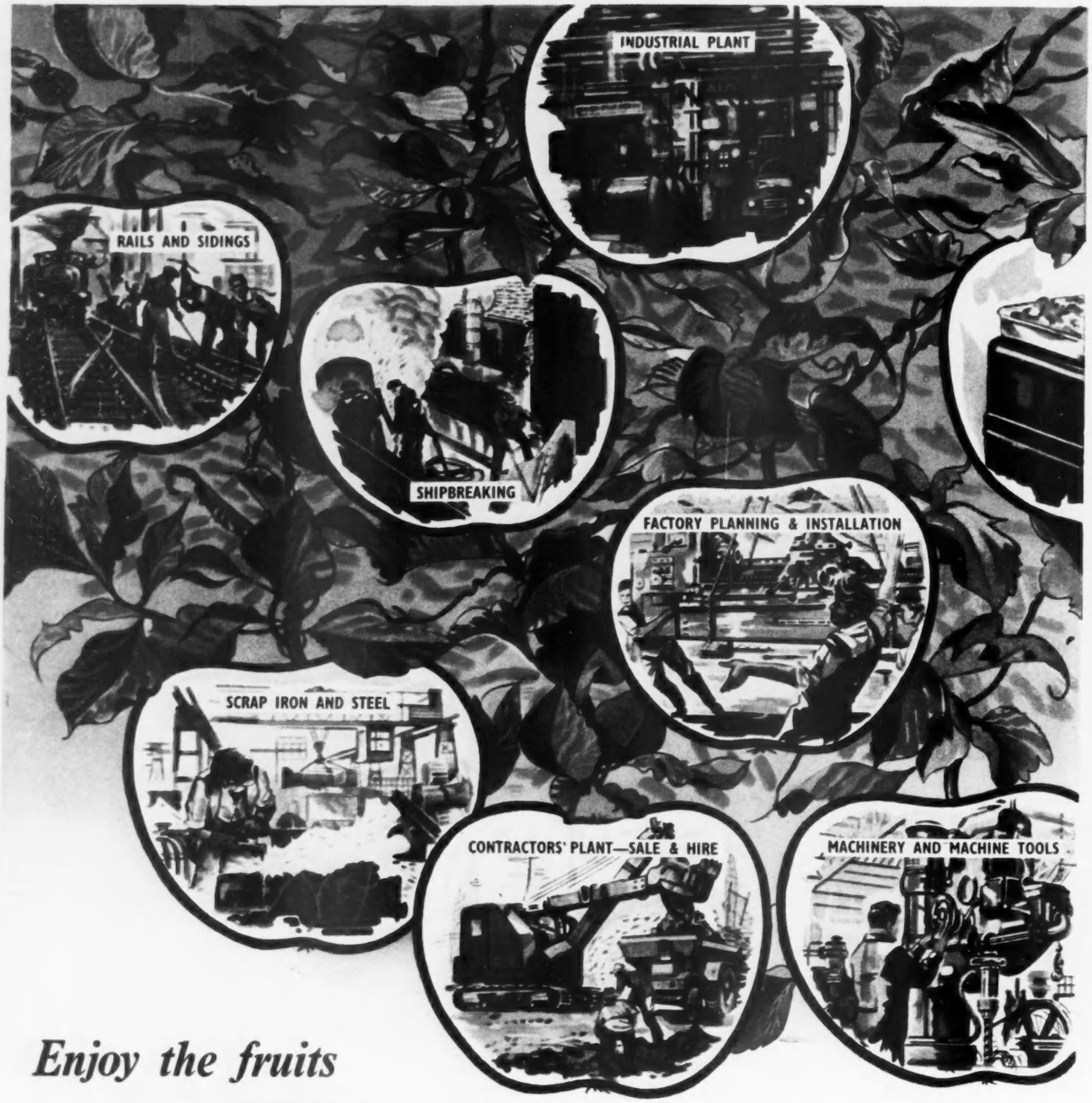

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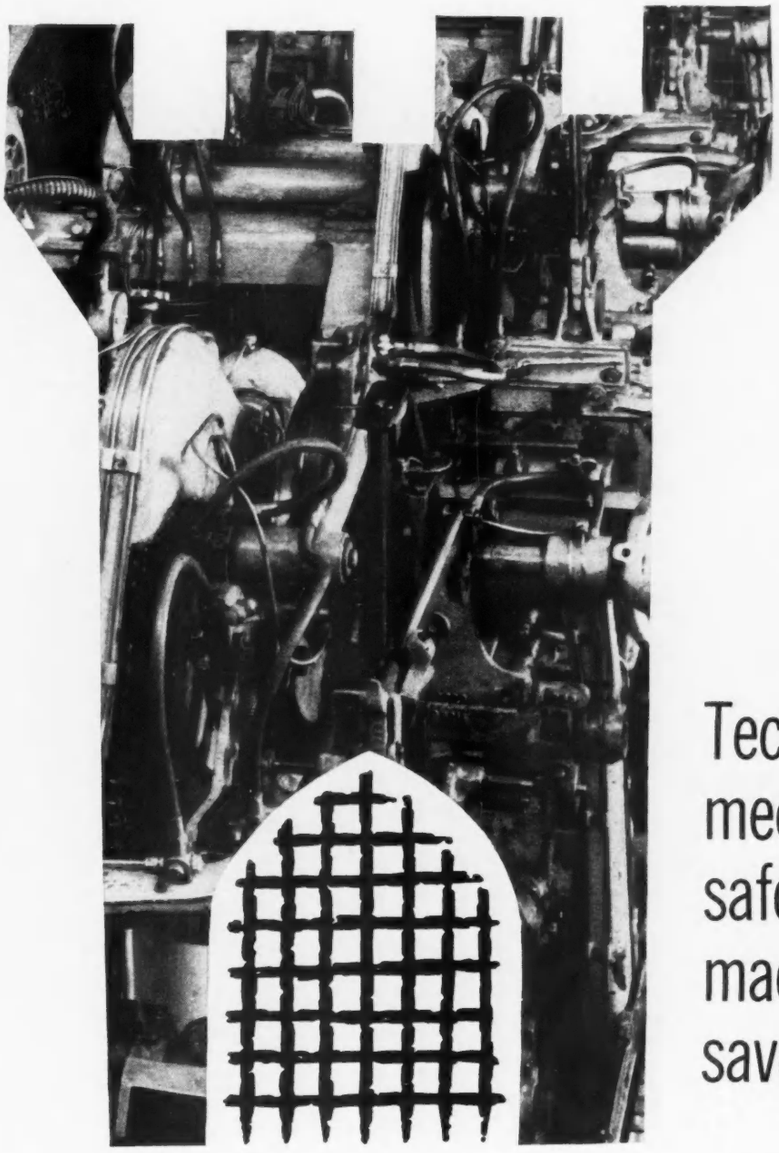

Tecalemit mechanical lubrication safeguards machinery and saves money

With Tecalemit Mechanical Grease Lubrication, every bearing gets exactly the right amount of grease at correct intervals. Machinery works better and lasts longer. Neglect and human error are eliminated.

There's a threefold saving—in power costs, in lubricant costs, and in labour costs. And there's a positive improvement in works safety when Tecalemit Mechanical Lubrication replaces frequent hand greasing.

The two main Tecalemit Mechanical Grease Lubrication systems are suitable for every type of installation. They can be incorporated into a new design or fitted to existing machines with equal success.

The SINGLE-LINE system uses a central pump, which can be fully automatic, operator-controlled, or hand operated, and a single main distributor line. Each bearing is fed by a separate Tecalemit Single-Line Injector, in effect an automatic metered grease nipple.

The RADIAL system incorporates 19 separate miniature pumps, each serving a bearing. Each pump's output is regulated according to need. The system can be driven from the machine it serves, or supplied complete with electric motor. Fully automatic, the RADIAL system is ideal for heavy machinery working at high pressure.

(There are also Tecalemit Mechanical Lubrication systems for use with every grade of lubricating oil.)

Tecalemit, the Authority on Lubrication, can solve *your* lubrication problem. Fill in this coupon and post it today. If you have a particular application or trouble-spot in mind, by all means enclose a note, a sketch or a drawing. You will be under no obligation whatsoever.

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TRANSFORMER ON-LOAD TAP-CHANGER

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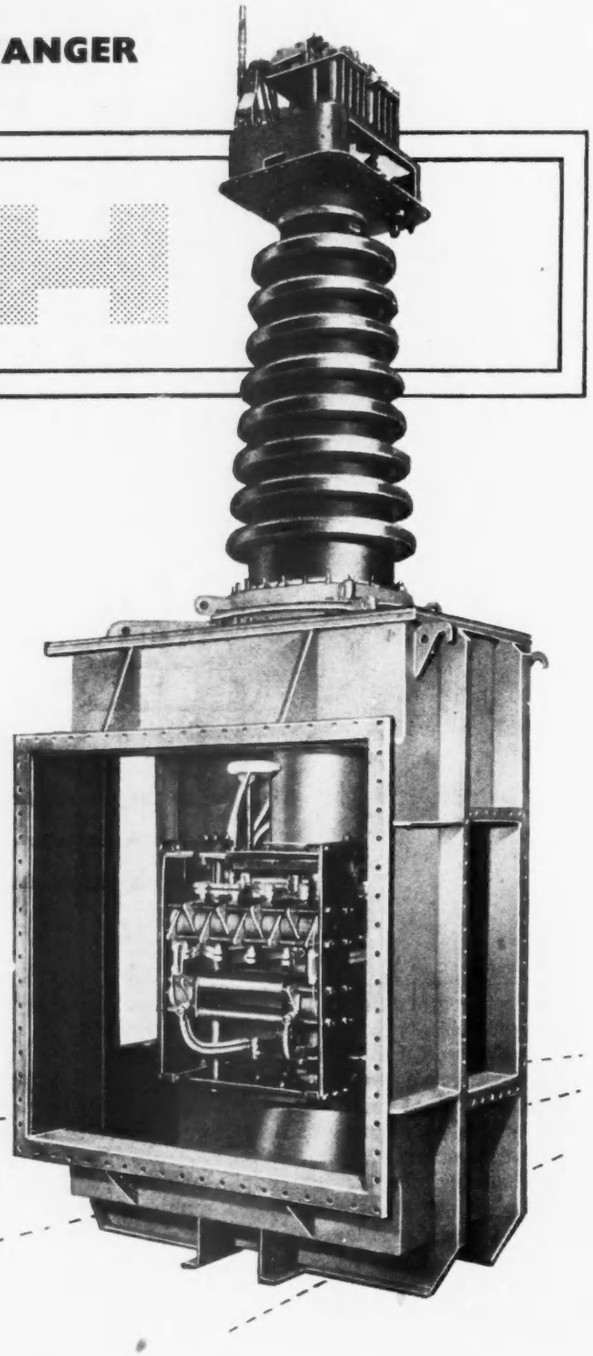
TYPE H



For service at the highest voltages the Type H tap-changer was developed for use with transformers on fully insulated systems. The simple and reliable mechanism ensures completion of tap change, and resistor transition minimises arcing at the transfer switch contacts. Type H Tap-Changing equipment is used by Associated Electrical Industries and other transformer manufacturers for 120 MVA and 180 MVA auto-transformers for the C.E.G.B. 275 kV supergrid.

Associated Electrical Industries Limited

TRANSFORMER DIVISION

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ACCURATE AND CONSTANT MESH

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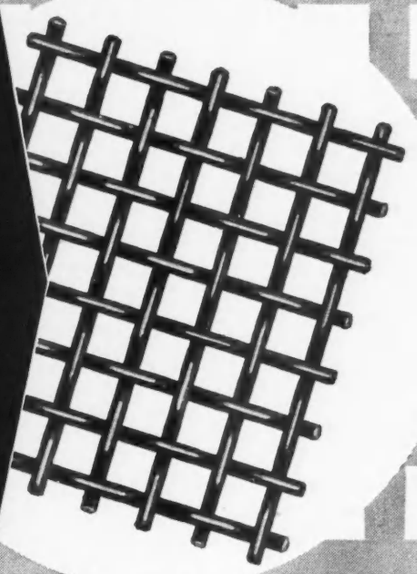

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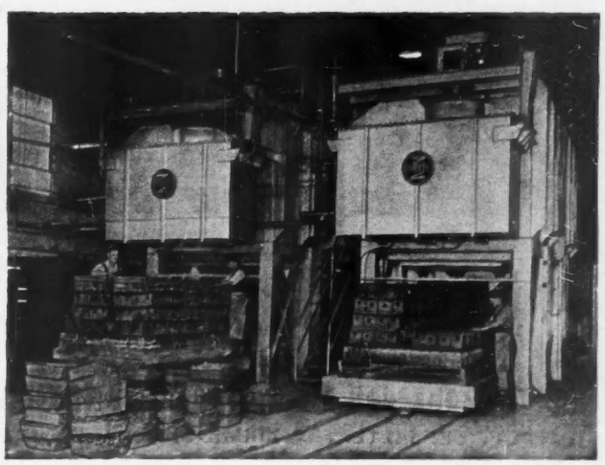

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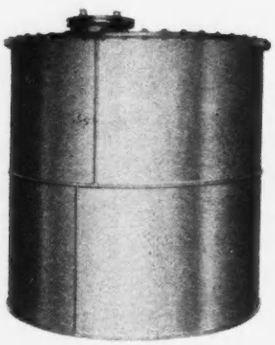

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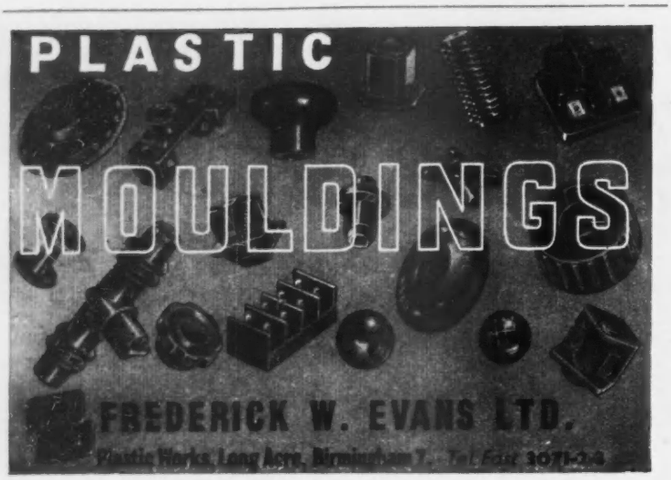

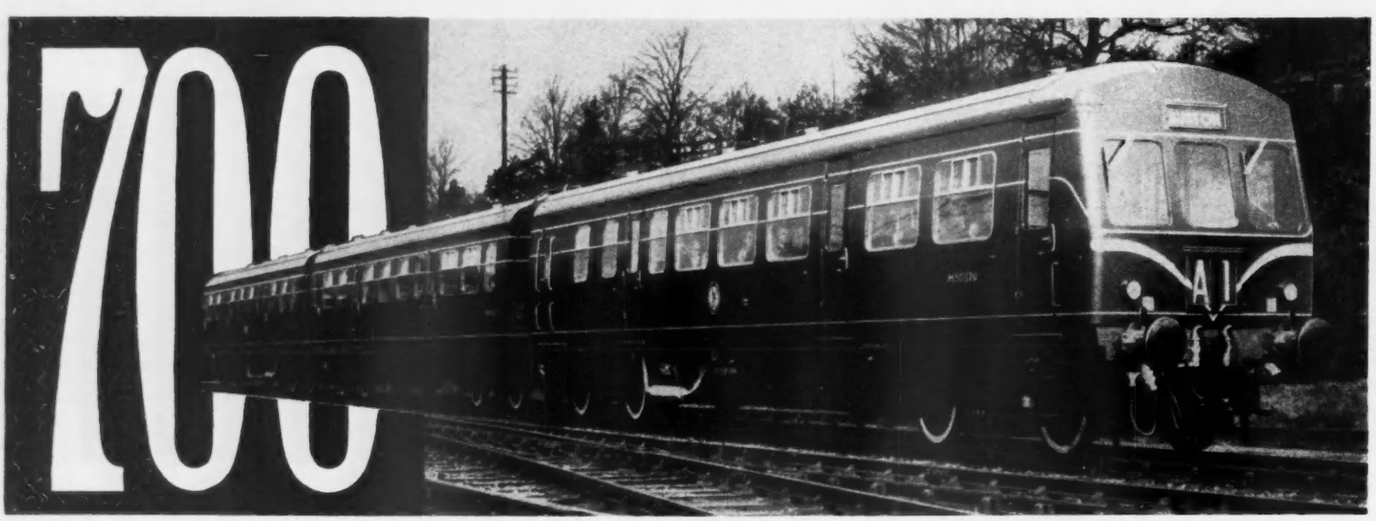

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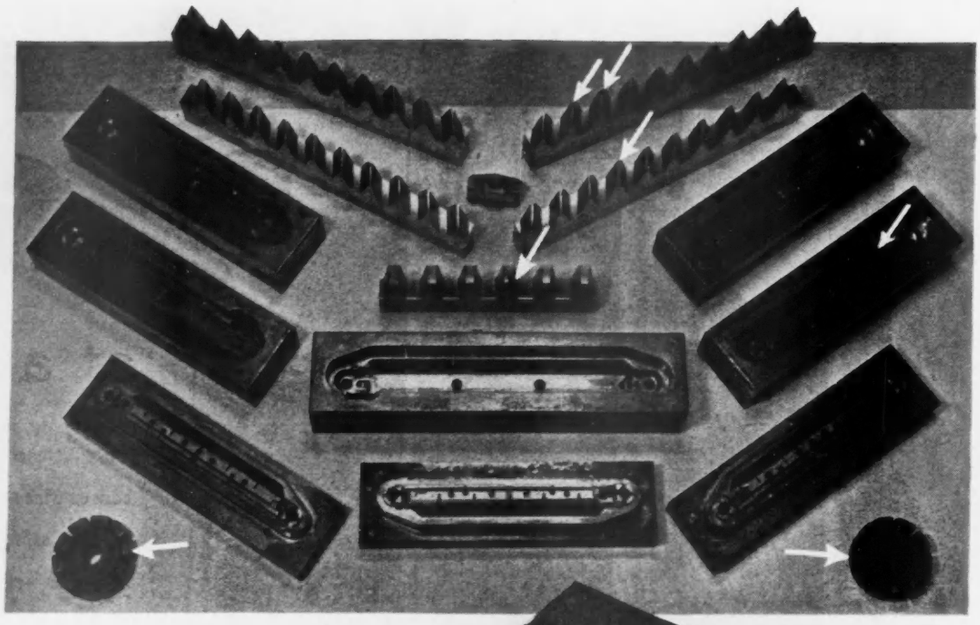

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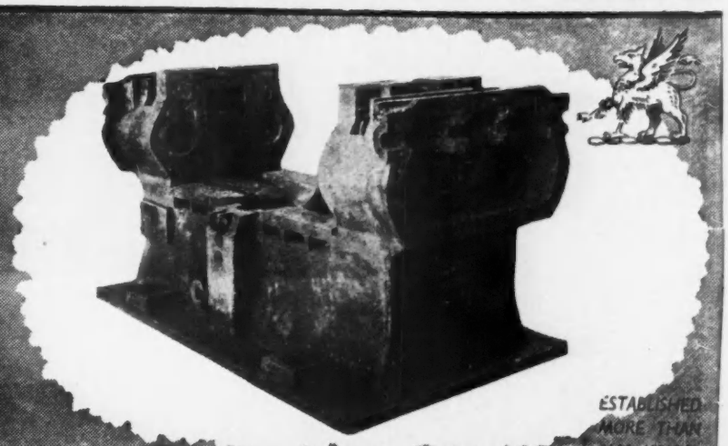

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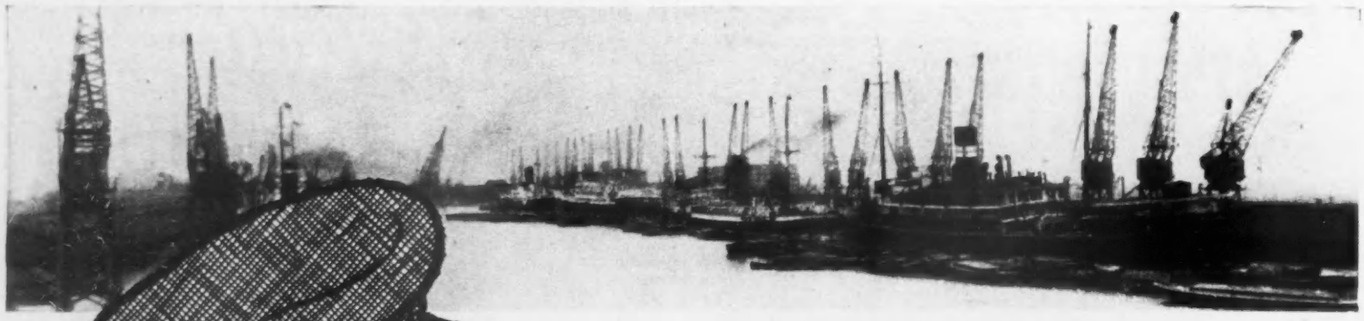

Silhouetted against a grey London sky these Stothert & Pitt 3 and 5 ton cranes with maximum radii varying from 65ft. to 90ft. stretch as far as the eye can see.

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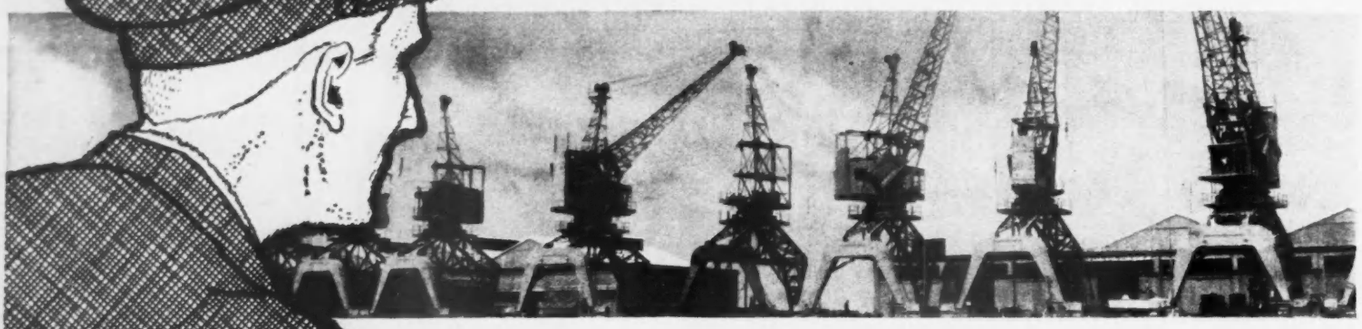
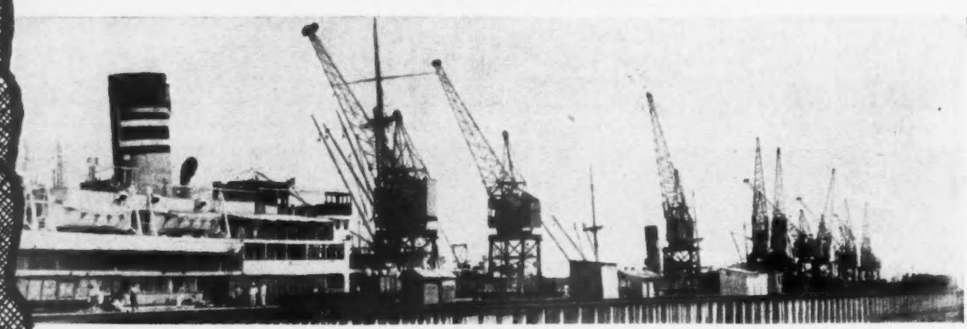


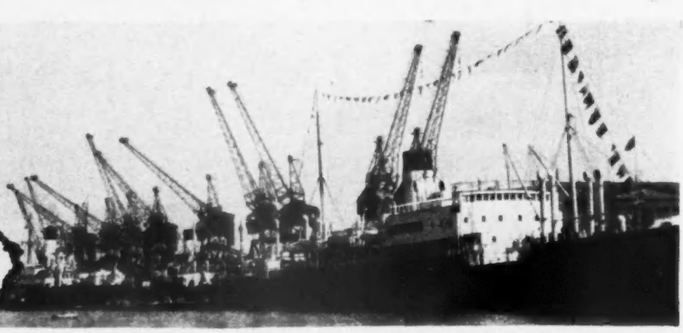
Many thousands of miles away, 3 ton cranes with 3 legged trucks and a maximum radius of 75ft. speed up cargo handling in India. Also in use at the same port are 6 and 10 ton cranes with maximum radii up to 75ft.

KANDLA, INDIA



In East Africa, the use of Stothert & Pitt 3 ton cranes with a 55ft. maximum radius ensures the quick turn round of large cargo ships.

BEIRA, EAST AFRICA



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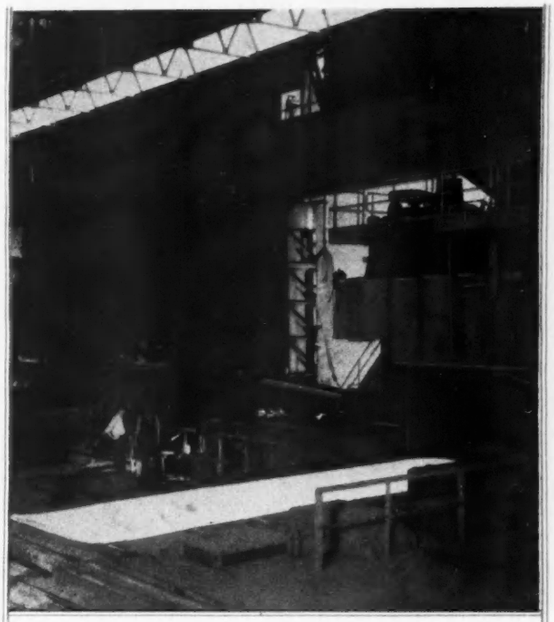

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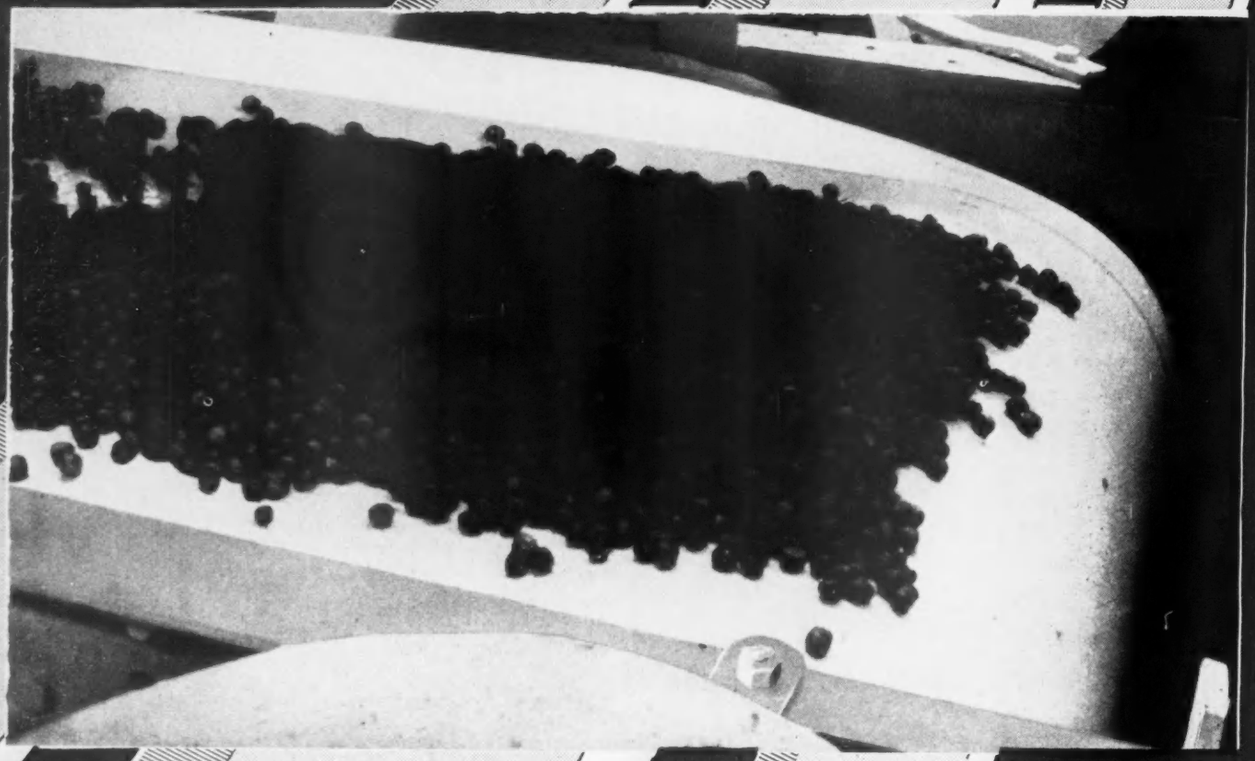

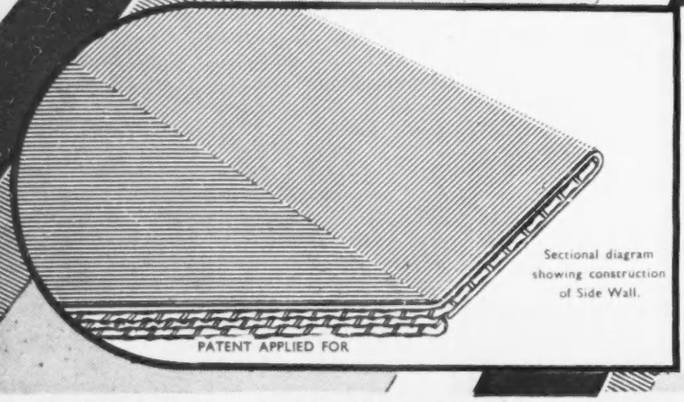

Sectional diagram showing construction of Side Wall.

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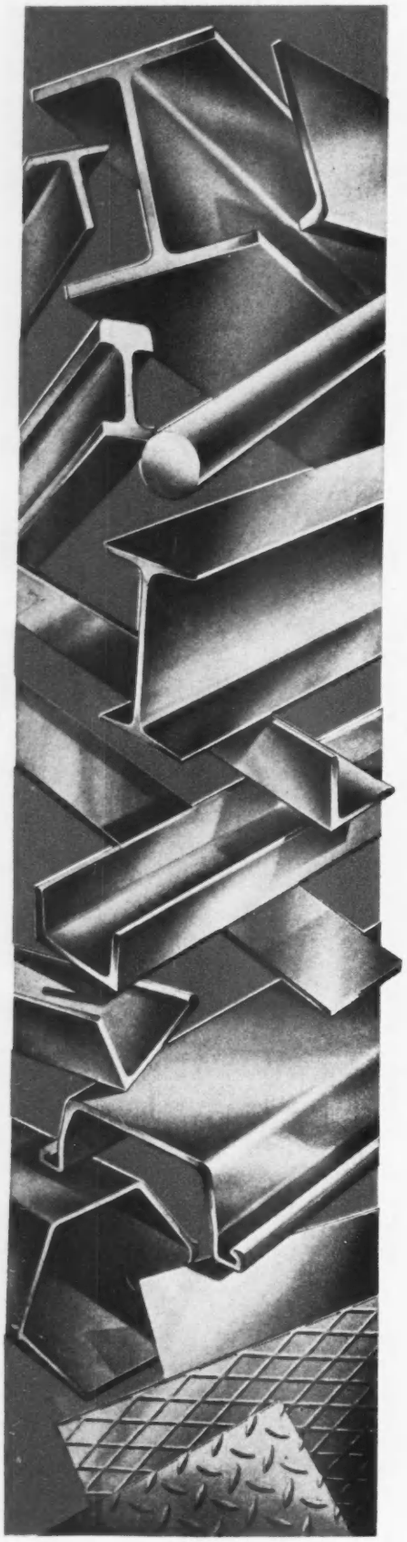

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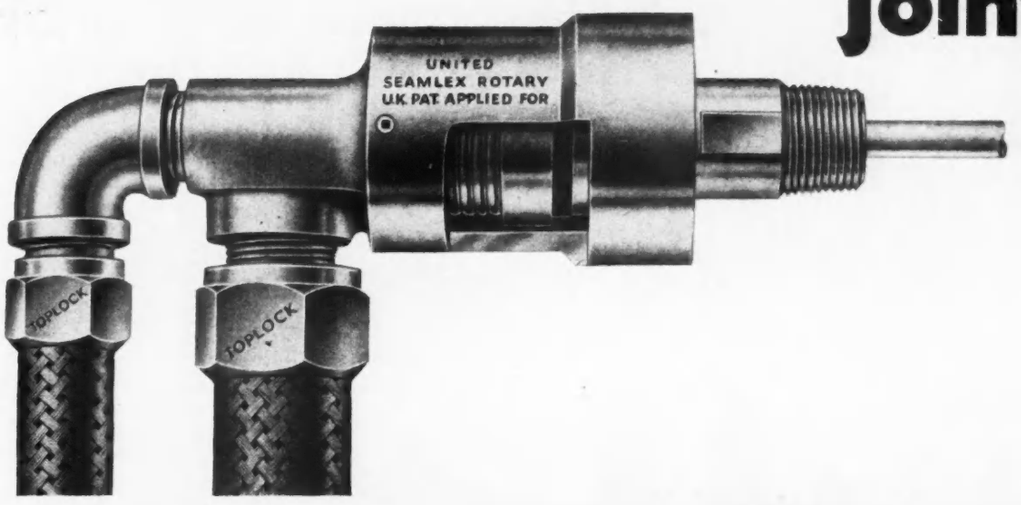

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The United Seamlex Rotary Joint is manufactured under licence from The Seamlex Company of Long Island City, New York.

with Triple Protection against Leakage

1

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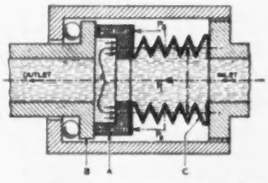
UNITED SEAMLEX ROTARYS maintain their steady leakproof performances under higher pressures because . . . regardless of the pressure in the supply line, the Pressure Equalizing Chamber automatically *reduces* the pressure to the minimum required for continuous, leakproof operation. The automatically *reduced* pressures cause less friction, prolonging the life of the seal, as well as the rotary shaft, thus providing effective protection against leakage.



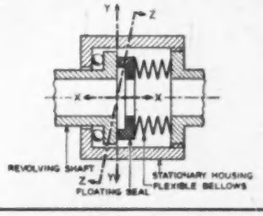
PRESSURE DIAGRAM

How working pressure P_1 + spring (Bellows) pressure P_2 is reduced by counterpressure P_3.

2

FLOATING GRAPHITE SEAL

The Seamlex *Floating* Seal, being flexibly mounted by means of a metallic bellows, is self-aligning, permitting it to move freely in any direction, axially as well as radially and obliquely. The *Floating* Seal absorbs smoothly the impact that is exerted upon it by a misaligned revolving shaft.



FLOATING SEAL

Self-aligning in any direction, axially X–X, radially Y–Y and obliquely Z–Z.

3

EXTERNAL PRESSURE ADJUSTMENT

This third exclusive feature contributes further to the continuous leakproof performance of United Seamlex Rotarys because . . .

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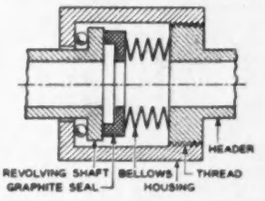

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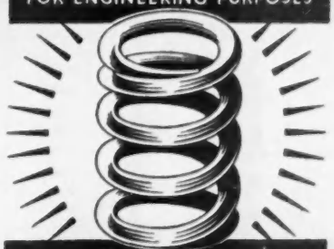

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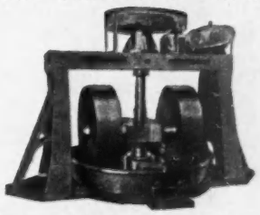

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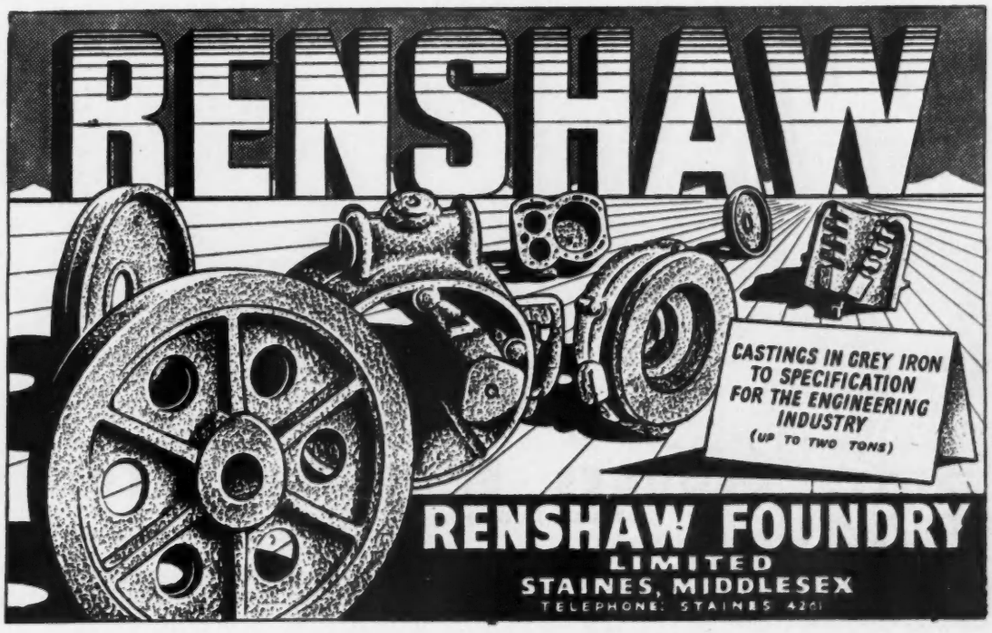

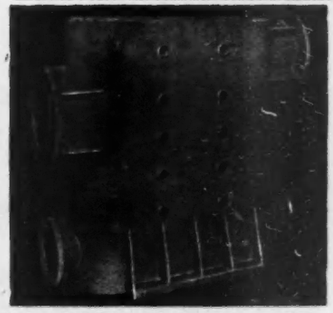

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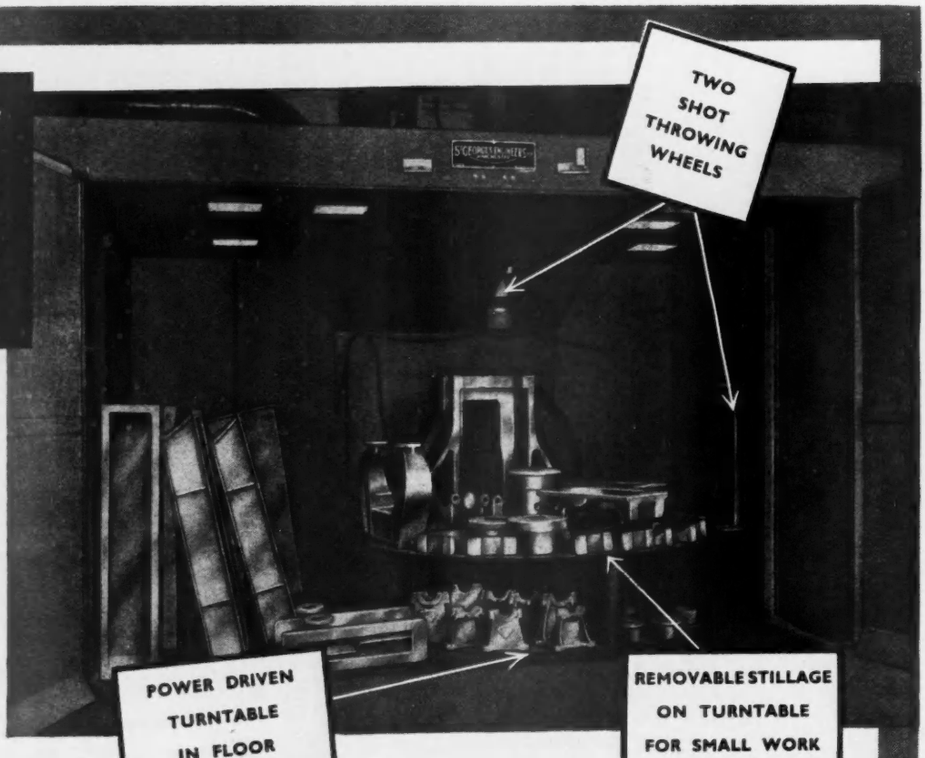

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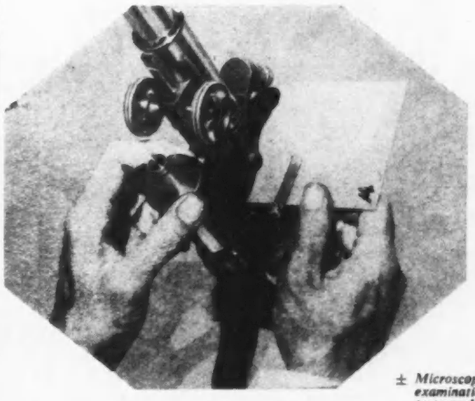

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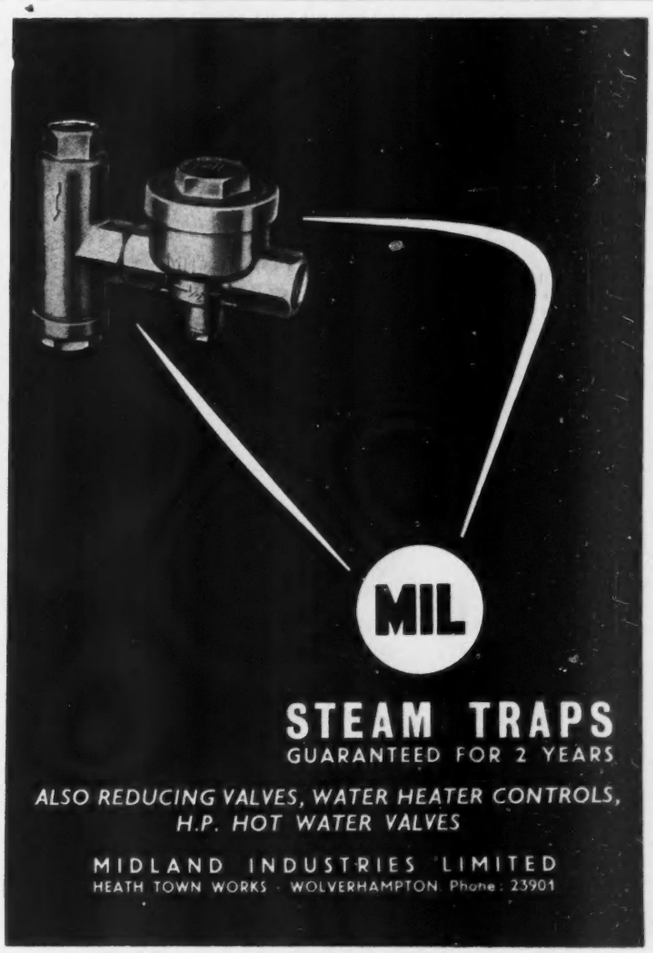

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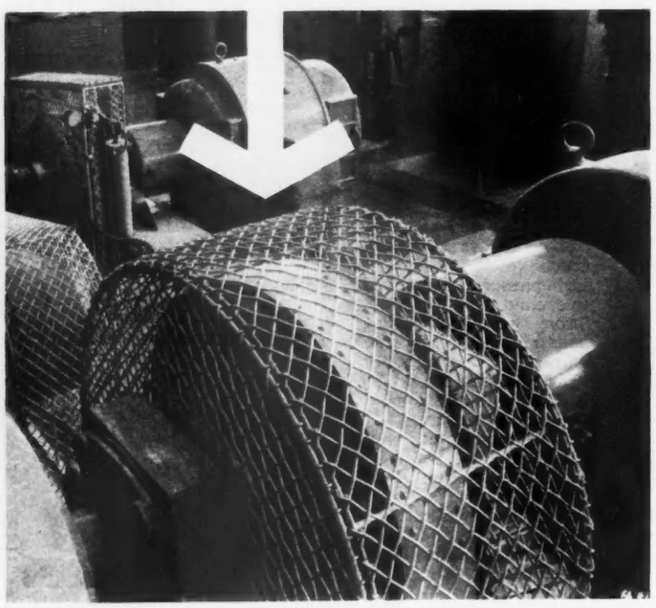

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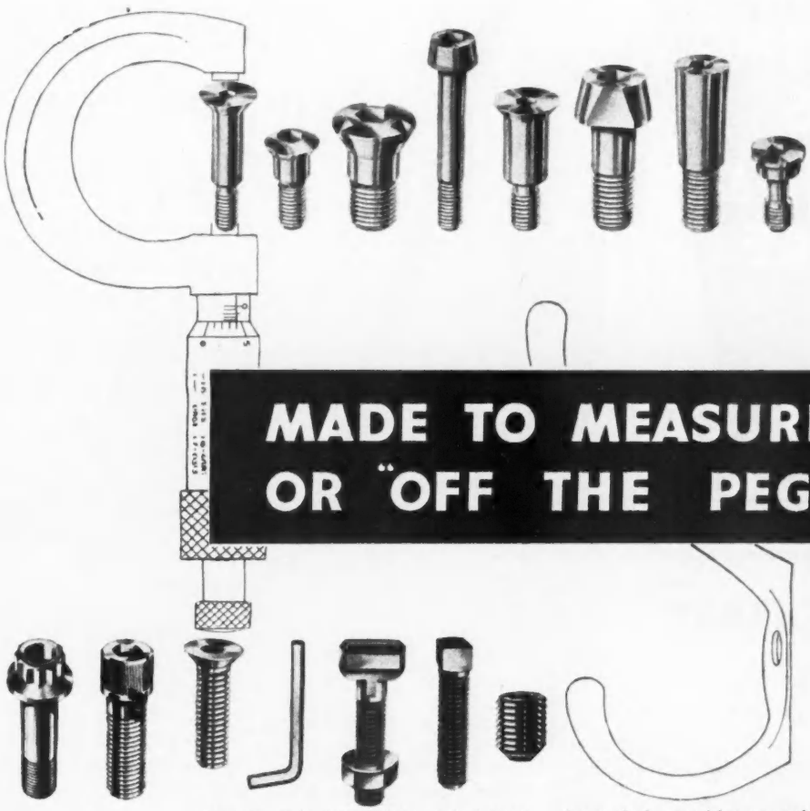

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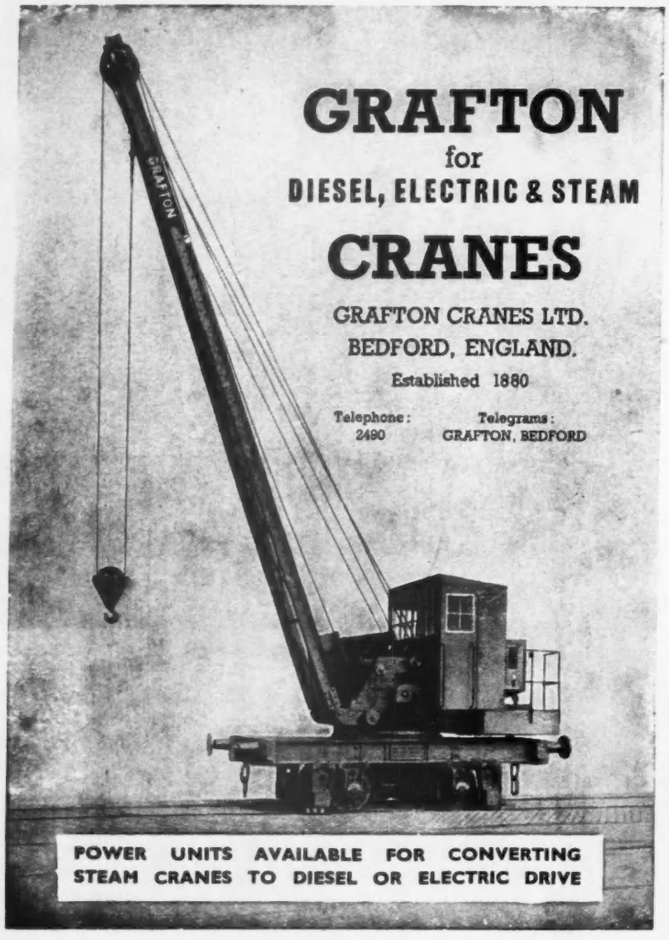

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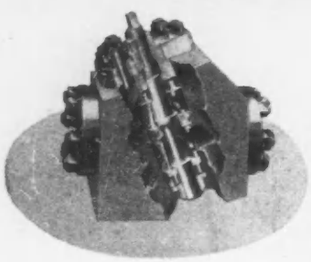
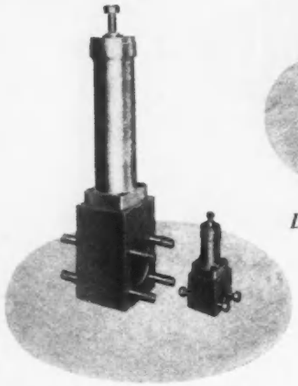
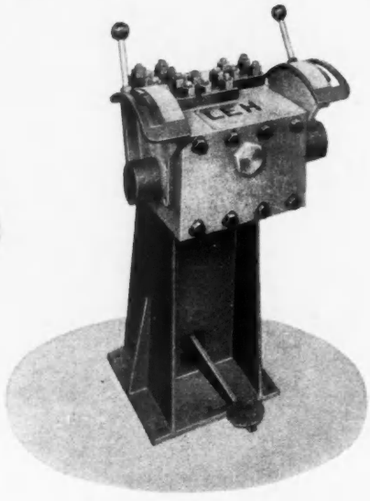


Balanced 'Inline' Stop Valve

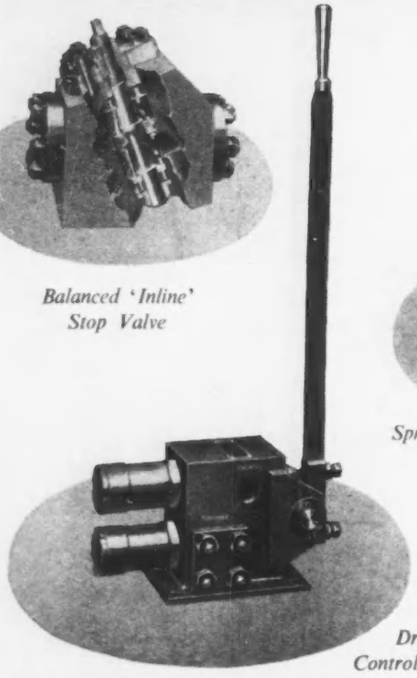


Spring Loaded Relief Valves

Drop Mitre Control Valve With Trip Gear



Piston Type Control Valve



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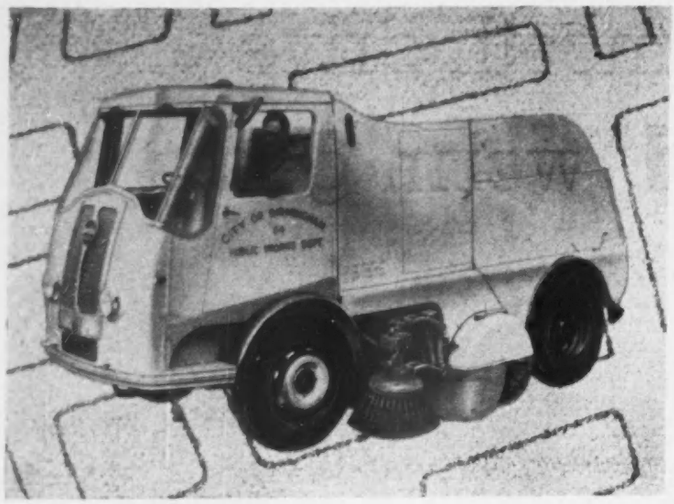

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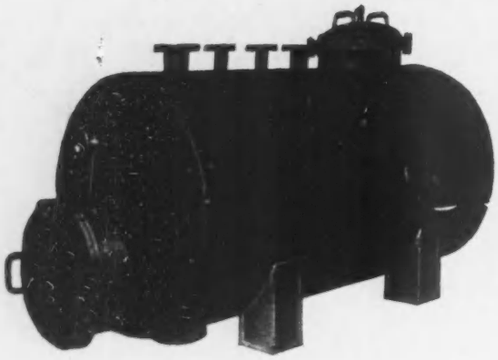

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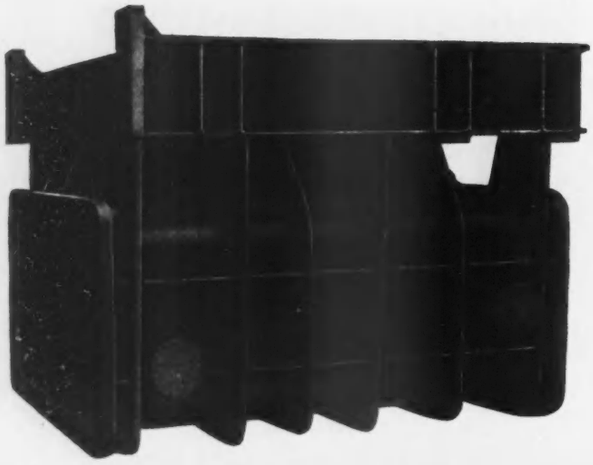

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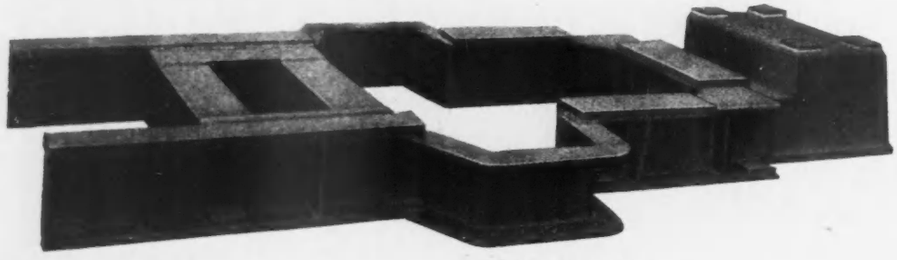

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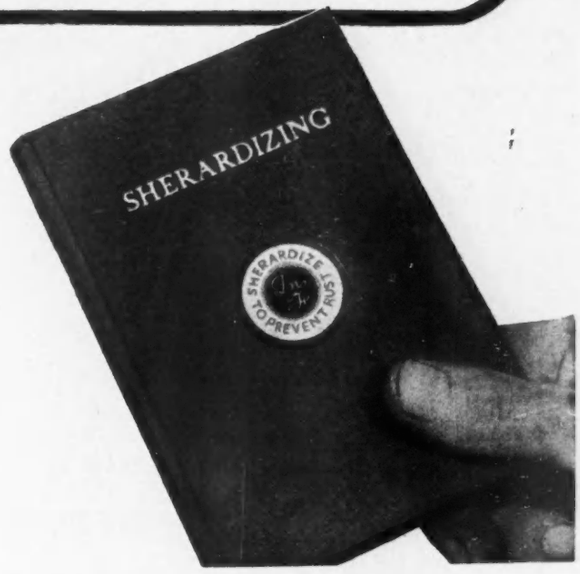

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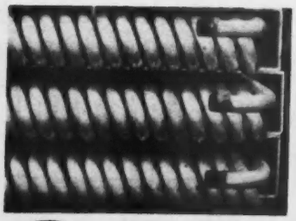

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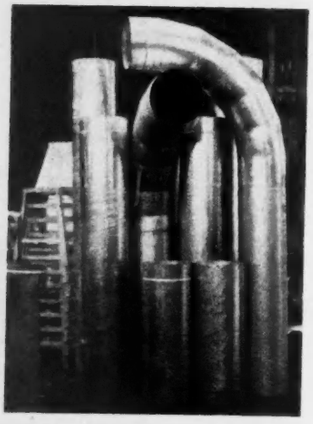

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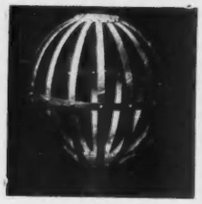

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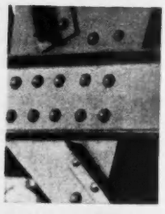

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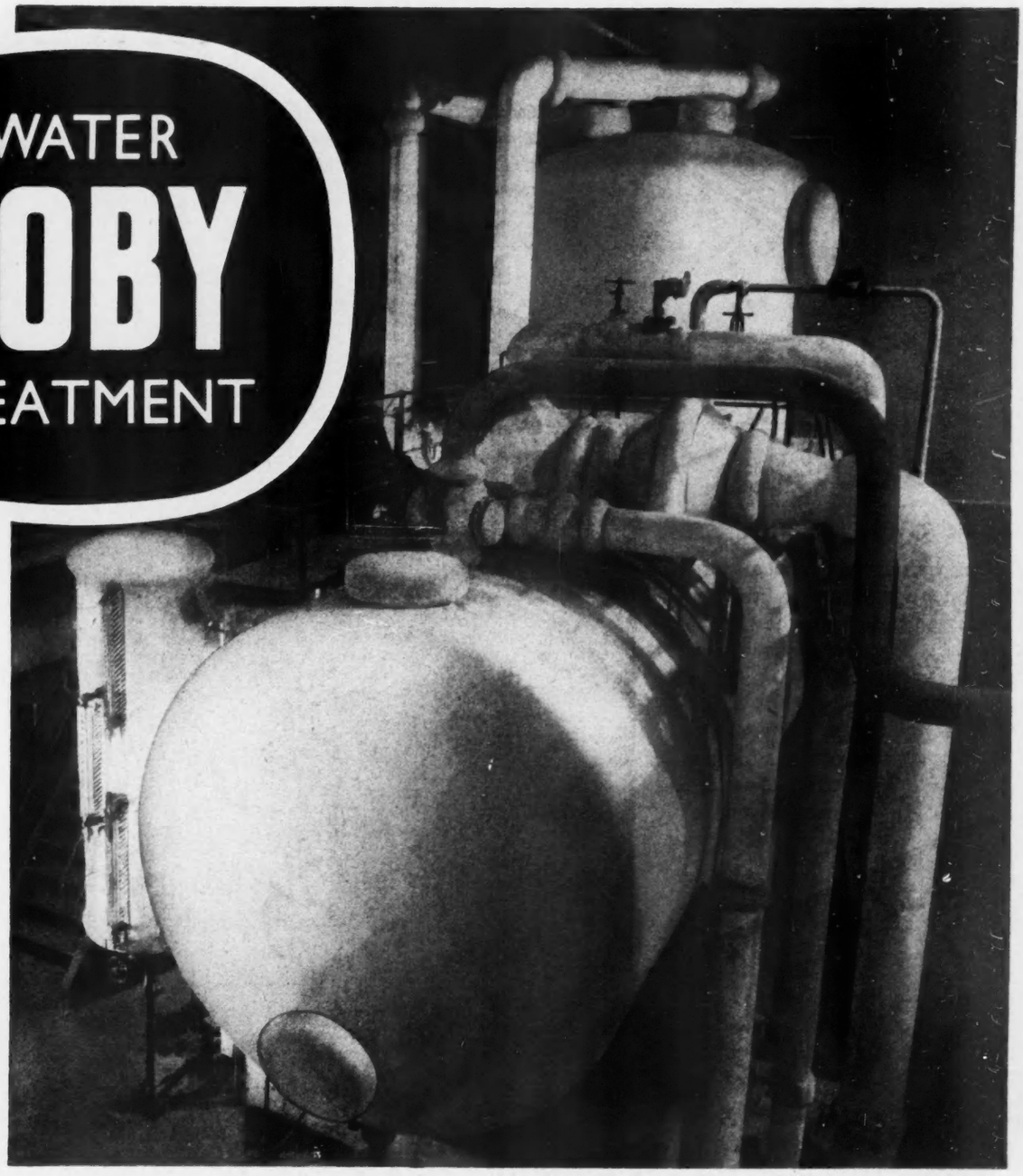

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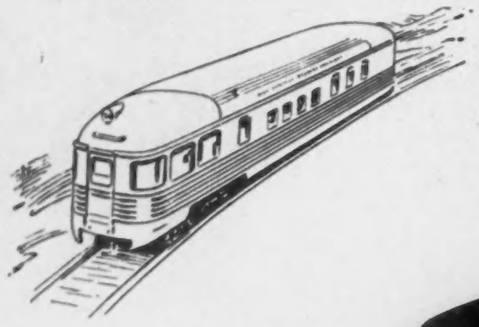

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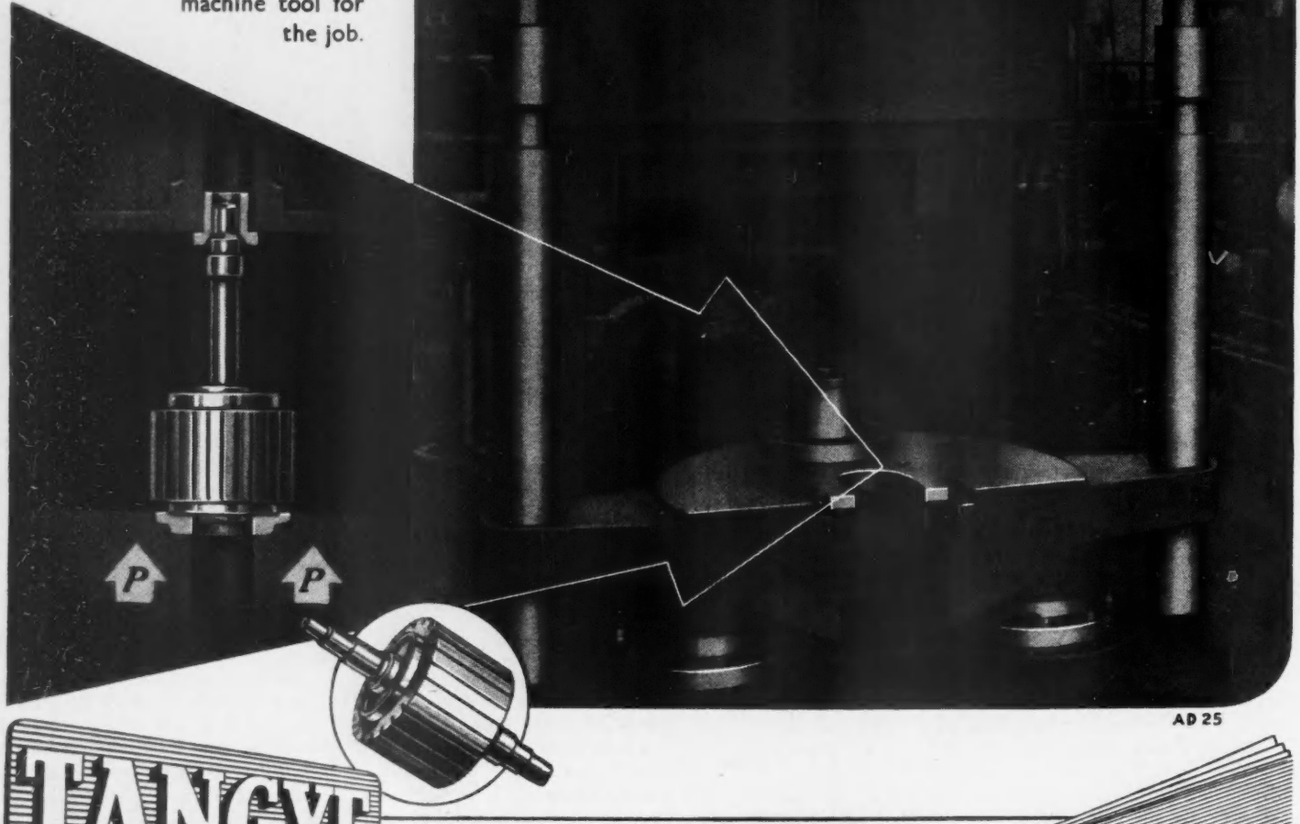

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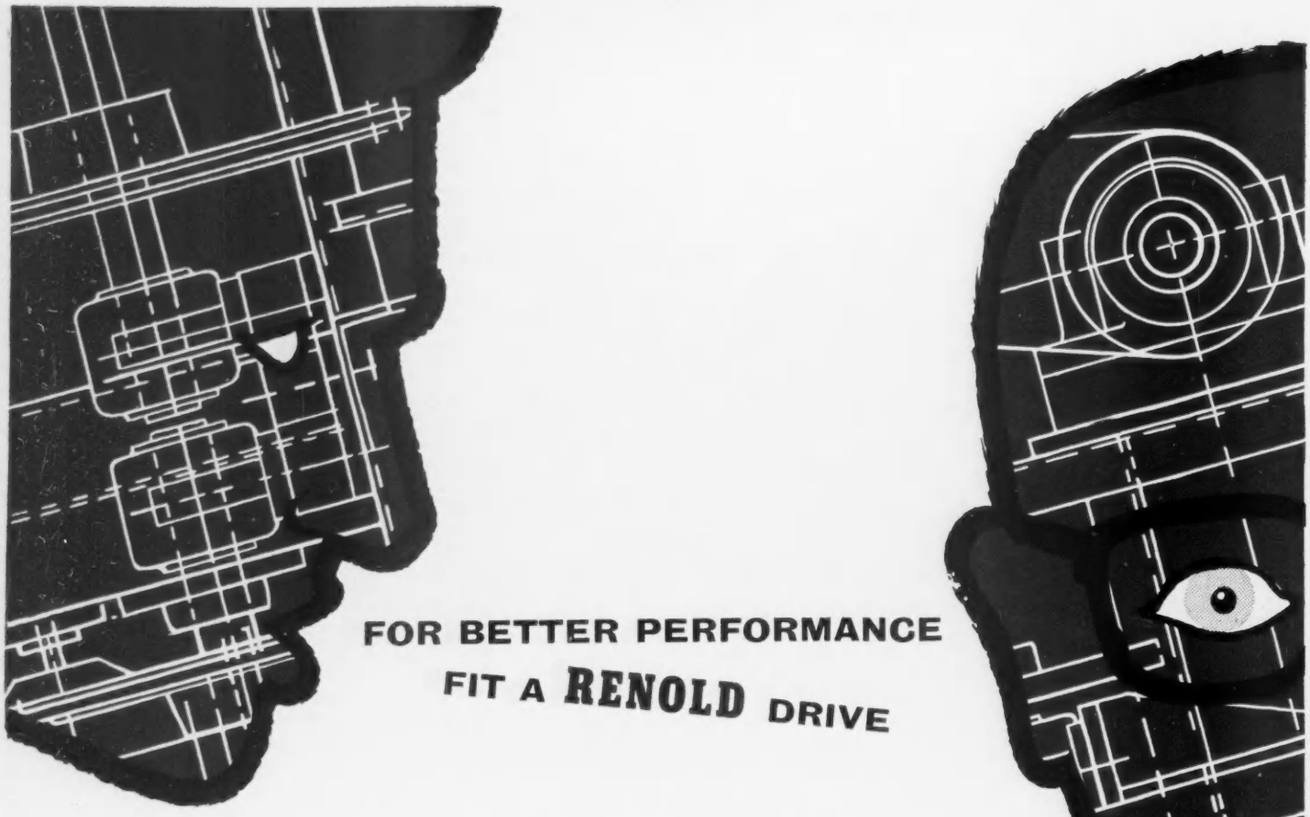

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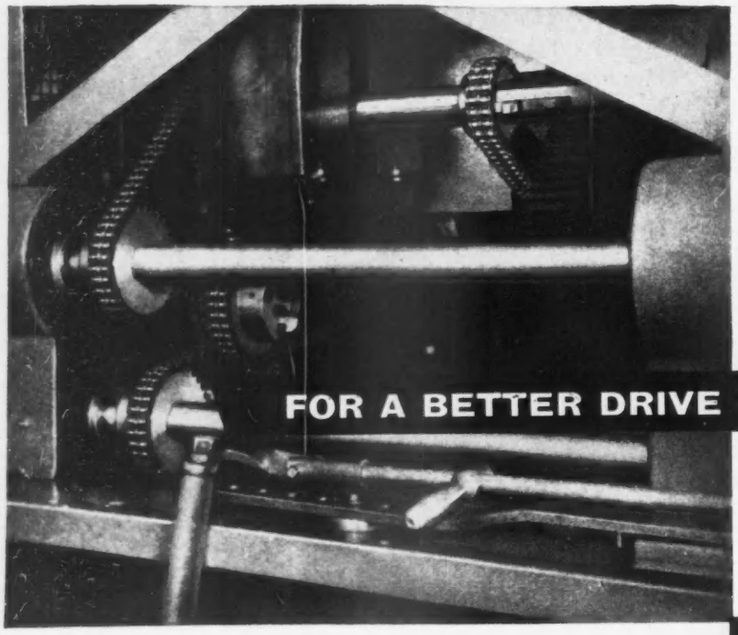

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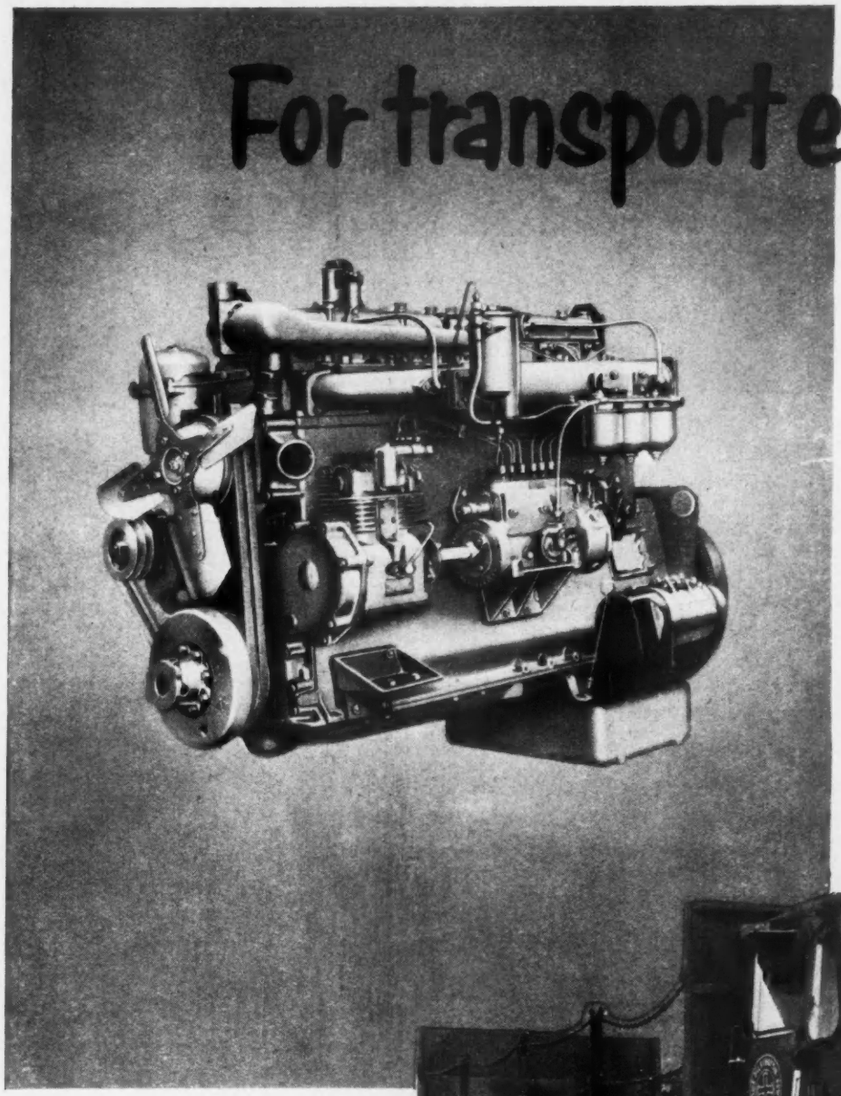

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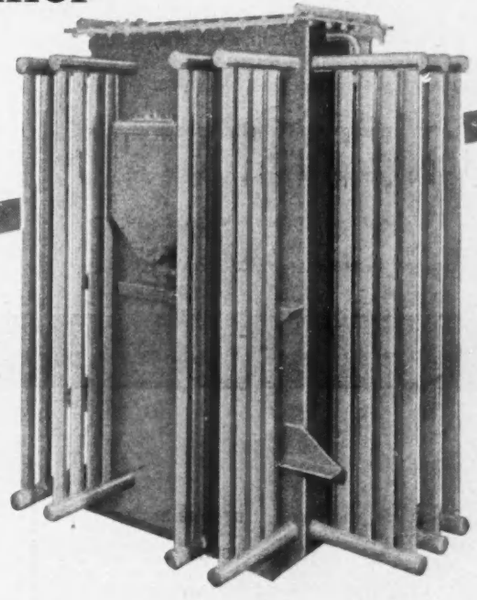

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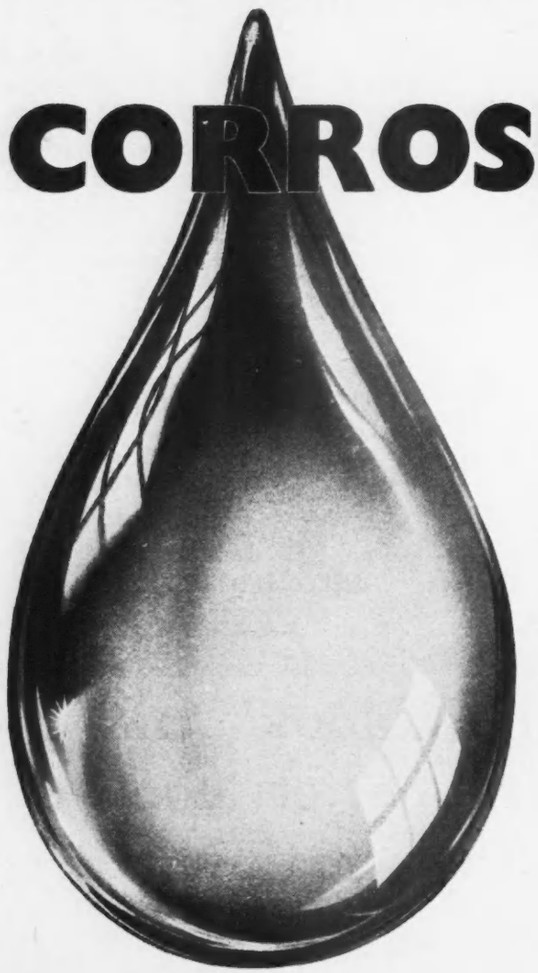

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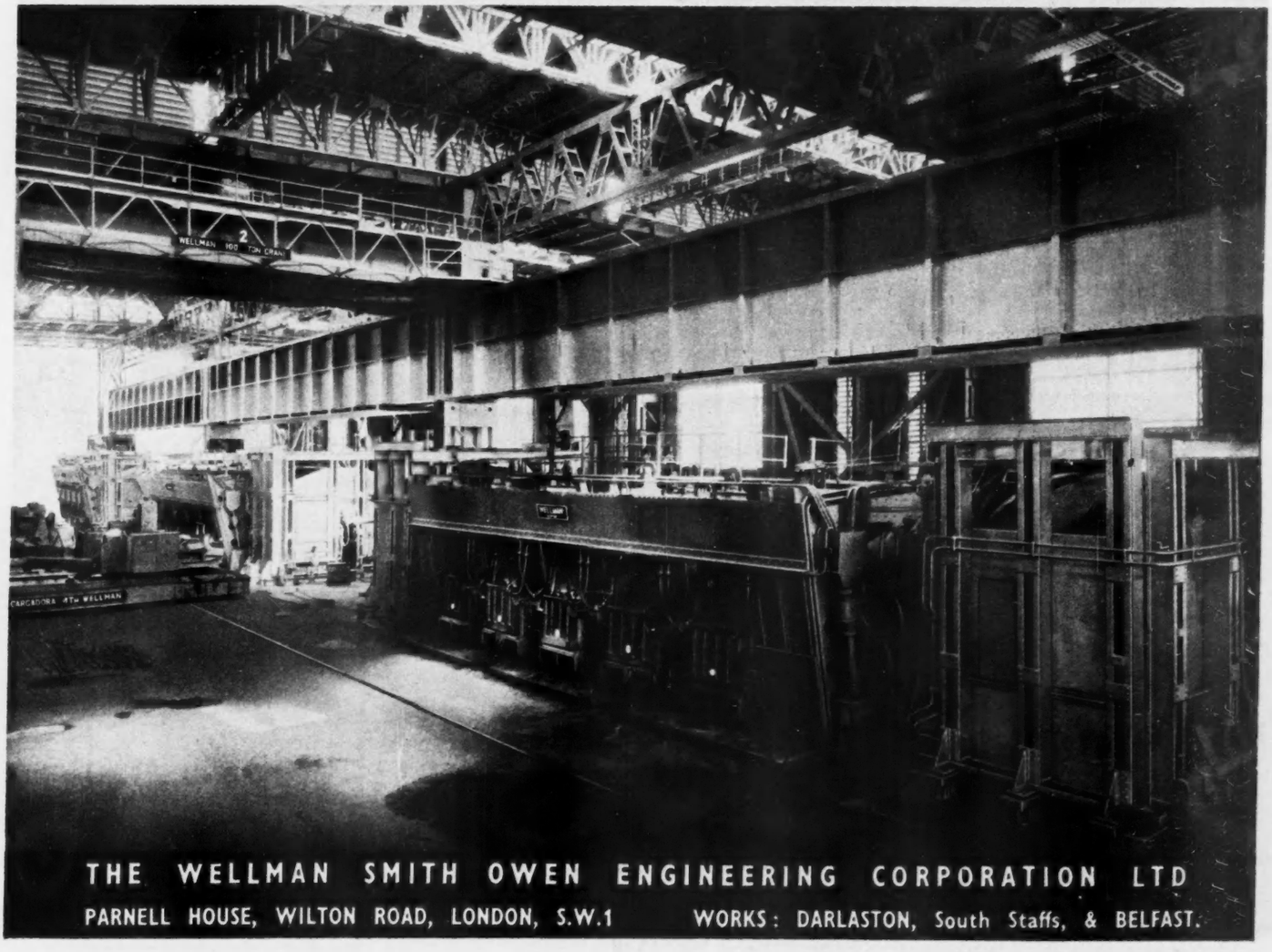

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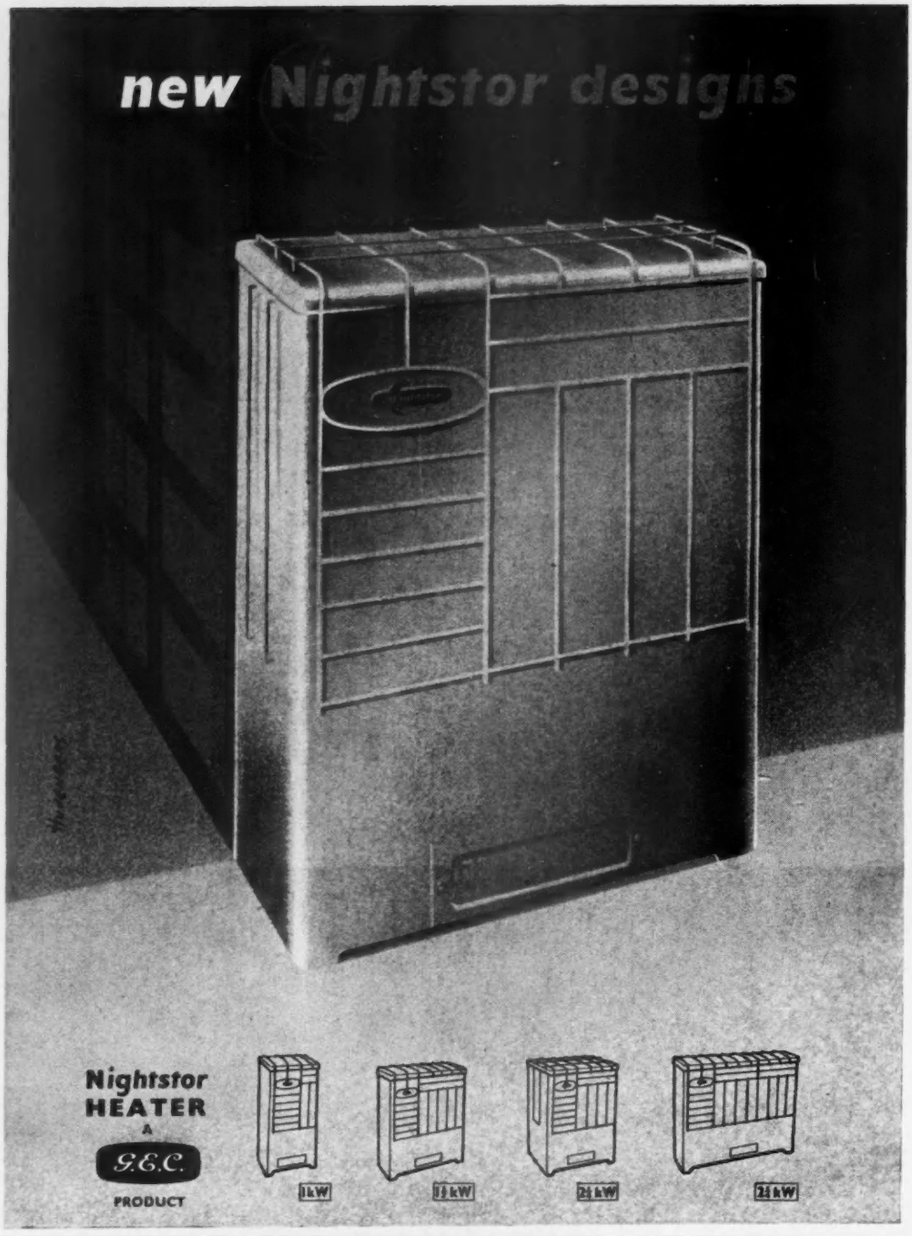

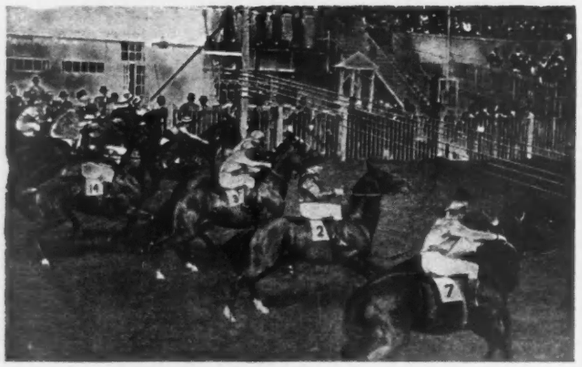

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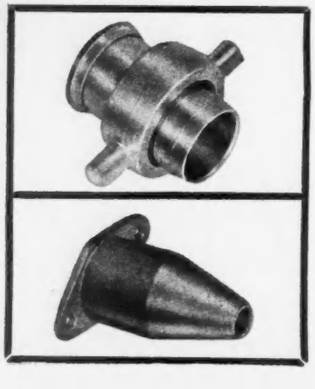

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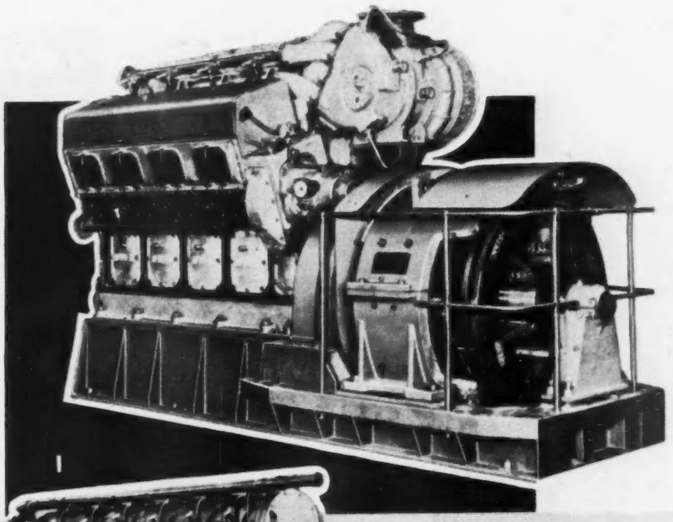

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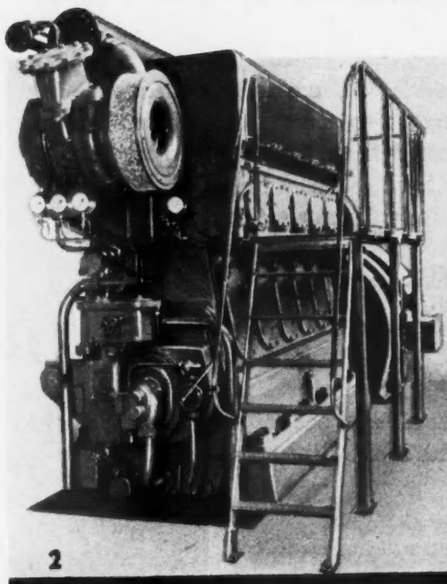

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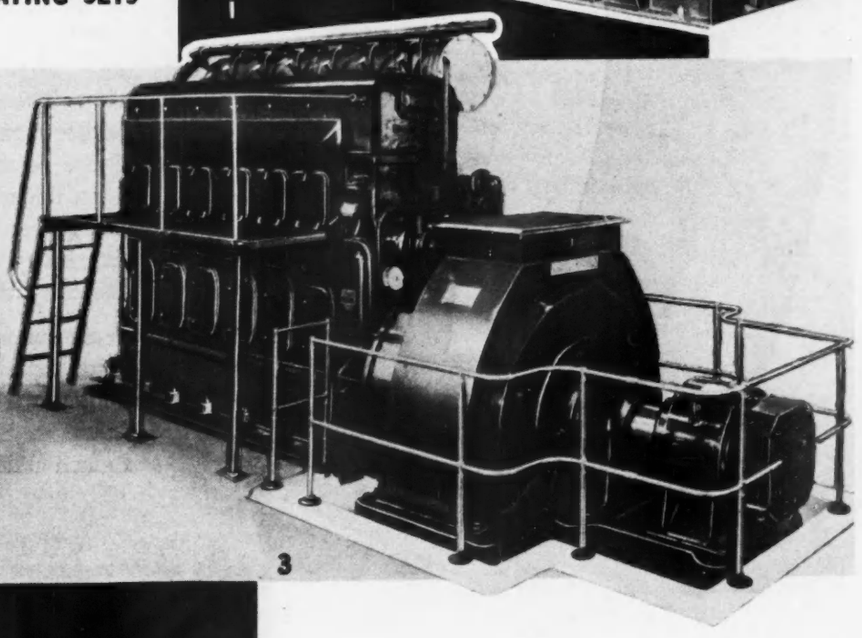

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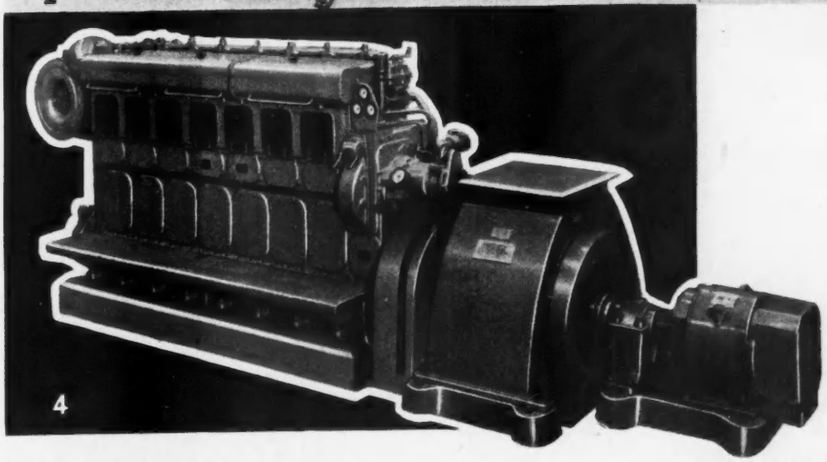

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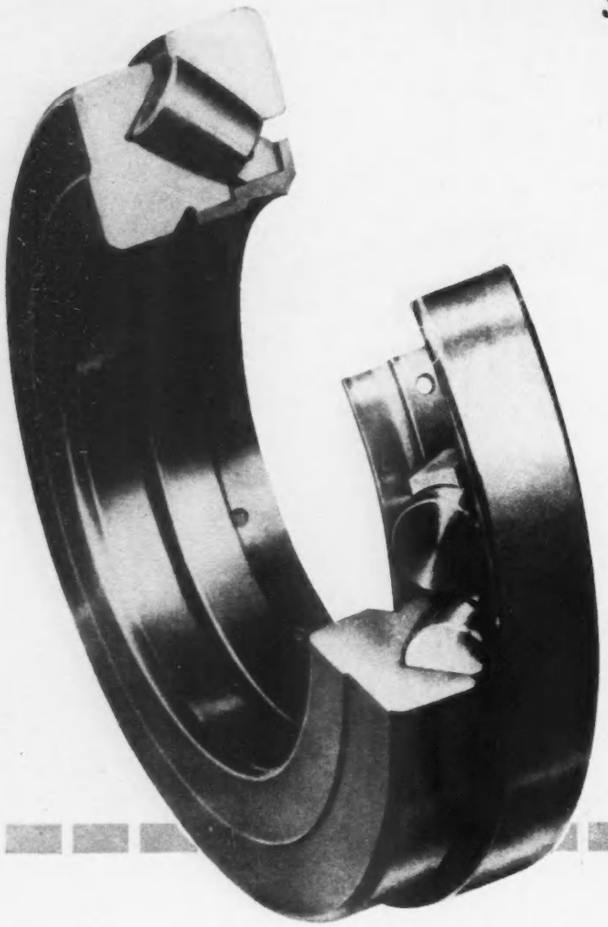

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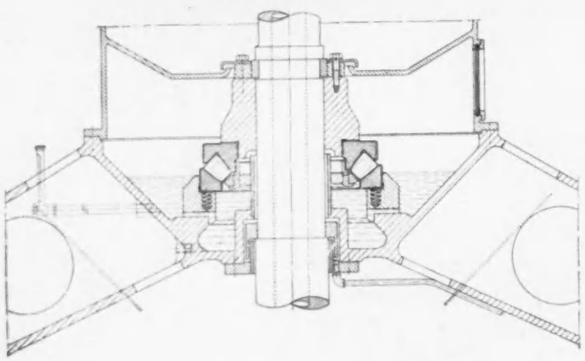
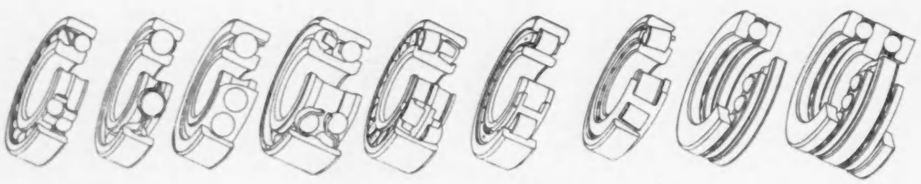


Support bearing for vertical electric generator



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THE ENGINEER

No. 5408 SEPTEMBER 18, 1959 VOL. 208

ENGINEERS AND THE BRITISH ASSOCIATION

Elsewhere in this issue we publish a commentary upon the proceedings at the meeting at York of the British Association for the Advancement of Science which terminated on Wednesday of last week. Here we are concerned to study the part that Section G (Engineering) plays in that organisation. Any engineer attending the meeting for the first time is likely to be struck by two things. First, remembering how very many engineers there are in this country and remembering, too, that Section G covers all kinds of engineering, he is likely to feel that the attendance is very poor. Upon inquiry, he will find that, apart from a mere handful of engineers who regularly attend British Association meetings, the bulk of those attending are drawn from the region in which the meeting is held ; and that a substantial proportion is composed of students of the university or college in which the daily sessions are held. Secondly, he is likely to feel that the quality of discussion falls far below that which he expects. Since preprints of most of the papers are usually available—they were absent at York because of printing difficulties, we imagine—the reason for that low quality is not to be found in the inability of the audience to study a subject beforehand. How comes it about that these criticisms can be expressed ?

We have suggested before, and we think it worth suggesting again, that the reason lies in a lack of clarity in the minds of engineers as to what Section G is trying to do. It must surely be obvious that Section G should not attempt to compete with the major engineering institutions in the kind of paper presented before it. For the highly technical paper beloved of the Institutions is out of place unless it can be assumed that a large fraction of the audience has specialised in the particular subject. At a B.A. meeting the audience, though technical, is never specialist. But if papers presented before Section G should not be highly technical, what kind of papers should be presented ? It is not altogether an easy question to answer. But it is clearly reasonable, in looking for an answer, to consider what the objects of the Association appear to be, remembering at the same time that Section G is peculiar in the Association in that it is the only section wholly concerned with the application of science. To quote from an article in this issue, " The broad picture at any modern meeting of the Association is that of scientists and technologists presenting and discussing their findings, not with other specialists in their own fields, but with scientists and technologists from other fields ; and trying also to make what they are doing intelligible and interesting to the public at large." We wish that in talking about the St. Lawrence Seaway at the York meeting, the Hon. Lionel Chevrier had been more audible in an echoing hall ; for we have the impression that his was a kind of paper very suitable for presentation at a B.A. meeting. It appeared to deal with the reactions of an engineering feat upon a national economy. In a different way it seemed to us that Mr. Conway accurately summed up what was needed in talking and showing films about " VTOL : An Aeronautical Challenge." Here was an expert presenting to a technical but non-expert audience a broad conception of his work and its problems. In the sense that he was pleading an engineer's cause before the public at large, Sir Ewart Smith's address may have fallen in well with B.A. purposes ; though we do just wonder whether a B.A. meeting is really the place to plead causes. Sir Ewart at least chose a subject of wide general interest ; and that his lead was followed up by a joint session with Section F, in which economists were able to express to engineers their views on the same subject, was surely right and something that could be done effectively only at a B.A. meeting. Some of the material presented before Section G at a B.A. meeting seems suitable enough therefore. Yet it still cannot be claimed that the audience attracted is a really satisfactory fraction of all the engineers who might attend, or even only of those who dwell within easy reach of a meeting. We do suggest, therefore, as we have suggested before, that a firmer attempt should be made to get, in addition, one other kind of paper. We would like to see at least one paper at each meeting presented by an eminent scientist from another section. It should be descriptive of his work and should express his opinions as to how it had already found, or might in the future find, engineering applications ; or, alternatively, it might be descriptive of any problems in his work which engineers might be able to help to solve, as, for example, by devising new instruments or new tools or new machinery. Really fruitful discussion might well be the outcome.

TRADE UNION DELIBERATIONS

During the five days of its annual assembly, the Trades Union Congress always manages to work its way through a varied agenda. There are so many matters upon which it feels bound to deliberate. Last week, for example, at Blackpool, there were resolutions concerned with such subjects as nuclear weapons, amenities in new towns, hospital out-patient departments, and the " activities of financiers, stock exchange speculators, &c.," as well as those more directly related to declared trade union policy and practice. T.U.C. declarations on general national and international affairs are given a good deal of publicity. We suspect, however, that the majority of delegates to the Congress, representing as they do a variety of unions, usually find their principal interest in subjects like the shorter working week, wages policy, conditions of employment, and so on.

The debate on these matters took place on Thursday of last week. Possibly, it was overshadowed by the announcement, made two days earlier, of the date of the General Election. The Congress agenda contained eight resolutions on a shorter working week. They were brought together in a composite motion which urged that a forty-hour week was essential to maintain a high level of employment and which called upon the general council to inform the Government, industrialists and employers, of the unions' " grave concern " over this pressing problem. Furthermore, the " continued resistance of employers " to the demand for a forty-hour week was

deplored. The resolution was carried, as was another on economic matters, which affirmed support for a policy of wage increases and complete opposition to any form of wage freeze. There, it can be said, the matter for the moment rests. The speeches in support of these resolutions contained no new arguments. The attitude of the T.U.C. general council has not changed, for while the general council avows its support of a shorter working week and no wage freeze, it still holds that it is the business of individual unions to press their claims. There was, however, one other matter discussed at this year's Congress of which much more may well be heard during the coming months. As reported in our last issue, a resolution instructing " affiliated unions to examine their structure and to define clearly the function of their officers and shop stewards " was rejected on the advice of the general council. But the general council has undertaken to examine in detail the whole subject of unofficial strikes and relevant matters. The council's spokesman pointed out very firmly that many disputes of this nature were over comparatively trivial issues which could be satisfactorily resolved if the agreed machinery and procedure were used. He emphasised, too, the importance of unions honouring agreements to which they put their signatures. If the general council's promised investigation leads to a more reasonable attitude over demarcation and similar trivial disputes in industry, the deliberations of the ninety-first T.U.C. may certainly have contributed something worthwhile to the solution of one industrial irritant.

" LUNIK II "

Another remarkable " first " in space exploration has to be credited to Russian engineers. At two minutes twenty-four seconds past ten (B.S.T.) last Sunday night the nose capsule of a Russian rocket, named by the Russians " Lunik II," landed on the moon. It landed one minute and twenty-four seconds later than the moment of impact as predicted by the Russians. Amongst laymen a certain sense of admiration can be detected because the landing occurred so very close to the predicted time after the object had travelled over 236,000 miles to get there. In fact, if the object had not arrived reasonably on time it would not have hit the moon, which was travelling roughly at right angles to the course of the object at 2200 miles or so per hour. Apparently " Lunik II " was equipped with no retro-rockets which could have been used to slow it down as it approached the moon and thereby convert a near-miss into a hit ; and, so far, information as to whether any " guidance " was possible after the burn-out of the last-stage rocket is conflicting. What is clear is that to obtain a hit on the moon the speed attained by the rocket at burn-out of the last stage had to be very accurate indeed—an accuracy of 1m per second has been claimed ; the direction of travel at that moment had to be highly accurate, too—we would have thought the accuracy " within 1 deg." reported to have been claimed was altogether too coarse ; and the launching time had to be accurate within a few seconds. By any reckoning it is a remarkable achievement and the Russian engineers who designed and built the rocket and its guidance system are to be congratulated. In rocketry it has once more been proved that the Russians lead the world. The Americans, too, of course, have had a shot or two at the moon. The Russian " Lunik I," which was fired on January 2 this year " towards the moon," which missed (if it was ever intended to hit) by some 4660 miles, and which became an artificial planet of the sun, is accompanied by American planets. But the Americans have a long way to go, it seems, before they can project into space objects as large as the Russians can and with as much precision. The instrument capsule of " Lunik II " is reputed to have weighed as much as 858·4 lb. It separated from the burnt-out, last-stage rocket, which is said to have weighed 3324 lb (inclusive of the capsule) at some predetermined time during the flight and even the Russians do not seem to know what has happened to the rocket case—whether, that is, it landed on the moon or has passed it by and become another planet of the sun.

But though engineers must be excited by this Russian achievement, scientists may prove rather disappointed. For there is no scientific value in landing an object on the surface of the moon unless it can send back messages about the state of the surface. " Lunik II " was destroyed on landing and its transmitters stopped functioning. The scientific value of its trip is confined to the information transmitted during its flight, information which will add to scientific knowledge about the belts of radioactive material which surround the earth, about the intensity of cosmic radiation and about the composition of interplanetary matter and gases. The only information about the moon which the instruments seem to have been designed to measure related to its magnetism, if any ; but it is reported that some kind of altimeter was brought into action as the surface of the moon was approached so that information may have been also derived about the existence of any atmosphere about the moon. The slightly late arrival at the moon's surface could conceivably be accounted for by retardation due to a very rarefied atmosphere. Scientists would have preferred the " Lunik " to have circled the moon, becoming a moon satellite, since it could then have provided valuable information about the moon's surface, its magnetism, if any, and several other matters. They would, too, probably, have preferred it not to have landed for certain biological reasons. It is regarded as of very high importance that the moon should not be " contaminated " with any living thing before man reaches it so that should life be found there it can be demonstrated that it was generated separately from life on earth. The Russians had the point in mind. Some kind of decontamination was carried out just before the rocket was launched and the capsule is reported to have had a device which released a decontamination mixture just before impact with the lunar surface. Let it be hoped decontamination was successful.

AERONAUTICS AT THE SCIENCE MUSEUM

In this issue we print a short article descriptive of the plans for an aeronautical gallery at the Science Museum in the new " Centre Block " now under construction at South Kensington in London, and due for completion about the end of next year. It is the top floor of the new block that has been allocated to the aeronautical collection and some 18,000 square feet of floor area will be available. Certain objects which have, of necessity, been in store for some years, and a number of wholly new exhibits, will be placed on view. The Museum is now asking for the co-operation of the aircraft industry in this major reorganisation and is seeking its assistance financially and through the loan or presentation of objects for exhibition.

There is, of course, nothing new about an appeal by the Museum for the support of industry ; for industry has long since recognised the importance of showing its products to visitors from home and abroad in the Museum's galleries. It has also recognised that whereas the Museum gets an annual vote under " Education " in the Civil Estimates, the amount, £260,000 in the present year, leaves little available for the acquirement of new exhibits or the modernisation and reorganisation of galleries. Amongst recent examples of industrial financial aid to the Museum there can be quoted the contribution

of £41,000 by the gas industry towards the cost of the gas gallery, opened in 1954. It also provided a number of models. Twenty leading agricultural firms quite recently made contributions totalling £10,000 to help to modernise the agricultural gallery. The cost of reorganising the electrical power gallery opened in 1957 amounted to £75,000. It was met by the supply and manufacturing sides of the industry. In February, 1959, the iron and steel gallery was re-opened. The cost of the reorganisation at £60,000 was met by the British Iron and Steel Federation. The chemical and automobile industries are at this time making contributions towards the reorganisations of their collections. Not all the cost falls upon industry, of course. The Ministry of Works provides, for example, not only the buildings and their maintenance but also furniture and services and a variety of models and settings, &c.

We have little doubt that the aeronautical industry, even though the appeal comes at a somewhat awkward time, will welcome the news that a new aeronautical gallery is to be created and will do all that is financially necessary. It is the function of the director of the museum and the advisory council to ensure that the new gallery is arranged in a way that will properly accord with the purposes of the Science Museum. Long ago one of the objects of the Museum was defined as the presentation of knowledge to the visitor in such a way that he will be attracted and interested and have his imagination stirred. Those words have an obvious and very direct relationship to the present-day need to recruit more scientists and engineers from amongst the ranks of talented young men. For the Museum, as it becomes more effectively arranged, should all the better stimulate the interest of young people in pure and applied science. We hope it will not be overlooked that it will the more encourage them to take up careers in those fields the better it shows, directly or indirectly, how effectively science and technology have influenced the development of the whole twentieth century way of life.

REDISCOVERING RAILWAYS

Support and encouragement is being given by the British Transport Commission to several radio and television programmes on railway subjects, two of which have already been increased in frequency or extended to new services as a result of a favourable public response. The importance of stimulating interest as widely as possible in railway techniques is evident at a time when arrangements have been made to use the services of certain staff of railways in the U.S.A. and Netherlands to tide over a shortage of signal engineers on British Railways. This unusual step, announced by Sir Brian Robertson in introducing the recent White Paper on the modernisation plan, to which we referred in our July 31 issue, suggests a lapse at some time in the supply of technical aspirants for the railway service. Spotters grow up and apparently grow out of their railway interests. Railway literature has never been more abundant, but much of it produced in recent years has looked backward to a period already fantastically remote from the generation which should be providing an intake of technicians. This seems to be appreciated by some of the producers of the programmes referred to above, one of whom has told us that the proportion of time allotted to the older railway enthusiasts' characteristic indulgence of regretting the snows of yesteryear will be severely rationed. Up to the second world war railway spokesmen on public occasions often pointed with satisfaction to the continued appeal of railways to youth in spite of rival interests on land and in the air. Various reasons were suggested for this—among them, a subconscious association of railways with early memories of holiday journeys. To-day a new approach is needed to enlist the interest and sympathy of those who perhaps remember the railway best as the sombre agency by which they were transported round the country on National Service.

While modernisation has increased the interest of technical railway work, it has also brought the railways into closer competition for certain staff with other forms of industry. Some of the older practices were wonderful to behold, but of no particular relation to any other activity (and some of these are not yet dead, for we read again recently of communication from a moving train in an emergency by writing a note on a piece of paper and throwing it through the carriage window). Perhaps signalling was once in this category and became the province of an inner ring of magicians so self-absorbed that they fell down on their public relations and failed to attract a sufficient supply of sorcerers' apprentices. Hence, the import of technicians from abroad. To-day, when the art is a compound of electrical engineering, telecommunications, electronics and optics, persons qualified in these subjects probably look first to other branches of industry in which they may be applied. In making a wide public aware of the present scope of railway work in all its technical branches, the radio and television programmes to which we have referred can perform a valuable service. Clearly, they cannot instruct in detail, but they can awaken interest in the railways as a source of careers

The Engineer—100 Years Ago (SEPTEMBER 16, 1859)

"SMOKE ON RAILWAYS"

"We have been requested to publish the following correspondence on this subject :

The Marquis of Chandos

MY LORD,—I take the liberty of writing to you, as chairman of the London and North-Western Railway Company, in consequence of my family and myself having suffered very great annoyance in travelling from Euston-square to Carlisle, on Friday last, from the large use of coal instead of coke in the locomotive engines. The effects were most disagreeable in various ways, which I will not trouble your lordship by describing. I have always believed that the public were protected by the law against so serious an inconvenience ; that the consumption of coal was contrary to law ; and that the use of coke alone was permitted. May I request your lordship to direct that I may be informed whether the use of coal in locomotive engines on railways be not contrary to law . . . I have the honour to be, etc., etc.,—T. F. KENNEDY.

"Right Hon. T. F. Kennedy

SIR,—I am directed to acknowledge the favour of your letter, to the address of the chairman of this company, and to express the great regret of the directors for any inconvenience you may have suffered whilst travelling on this line, and to assure you that, as heretofore, so now, it is of course their desire and intention to comply with all the requirements of the law to the utmost of their power, whether in the matter to which you specifically refer, or any other. I am directed to add, that as regards that specific matter, it does not appear that there is any legal or other reason why coal should not be used in the engines under proper regulations.—I am, Sir, your obedient servant, CHARLES STEWART, Sec."

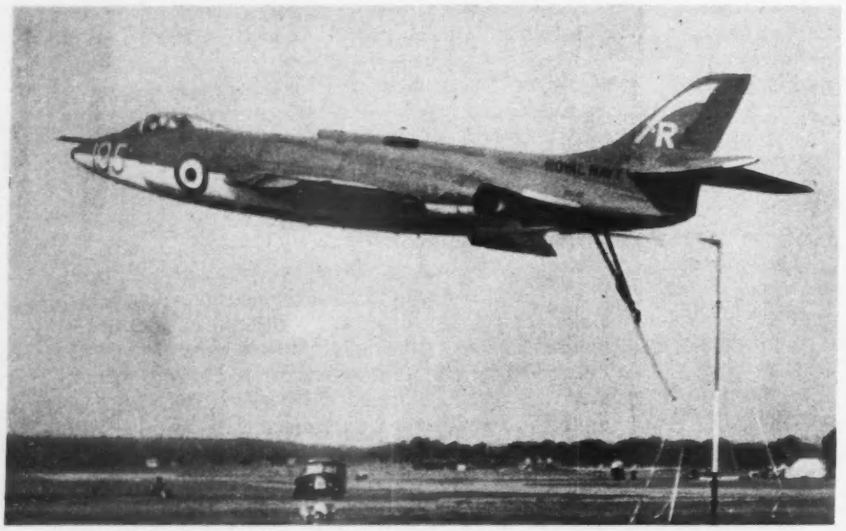
S.B.A.C. Flying Display and Exhibition, 1959

No. II—(*Continued from page* 217, *September* 11)

The twentieth Flying Display and Exhibition of the Society of British Aircraft Constructors was held last week at Farnborough Aerodrome. Below we continue our account of selected items in the flying programme and static exhibition.

ON the public days there took place at mid-day a demonstration of some British sailplanes. The craft flown were the EoN "Olympia" 403 and 419, and the Slingsby "Skylark" Mark 2 and Mark 3, and "Eagle" T.42. The "Eagle" carried a crew to it: its aerobatics appeared to include a stall in inverted flight. The "Olympia" 419, which employs a laminar flow wing, also executed a variety of manœuvres in inverted flight.

An addition to the advertised programme

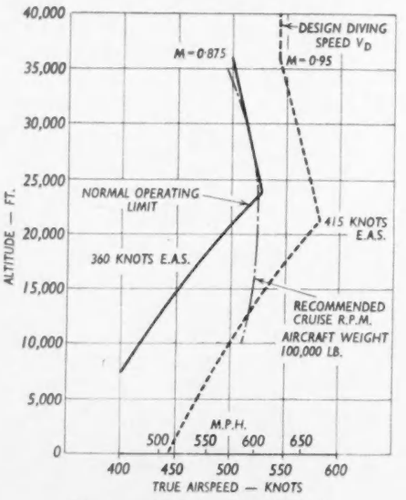


A "Scimitar" snatching a towed target: notice the drooped leading edge, depressed flap and deflected tail plane

of two during its flight. The "Olympia" 403 and the "Skylark" 3 were towed together by a "Prentice" tug, casting off in turn. The "Skylark" 2 was towed by a Miles "Messenger" and flew past the spectators side by side with the tug while still attached of flying was the Short S.C.1 vertical take-off and landing research aircraft: this demonstrated flight with powered lift, but did not complete a full sequence of appearances as a result of aspiring grass cuttings into the intakes.

Aircraft Projects

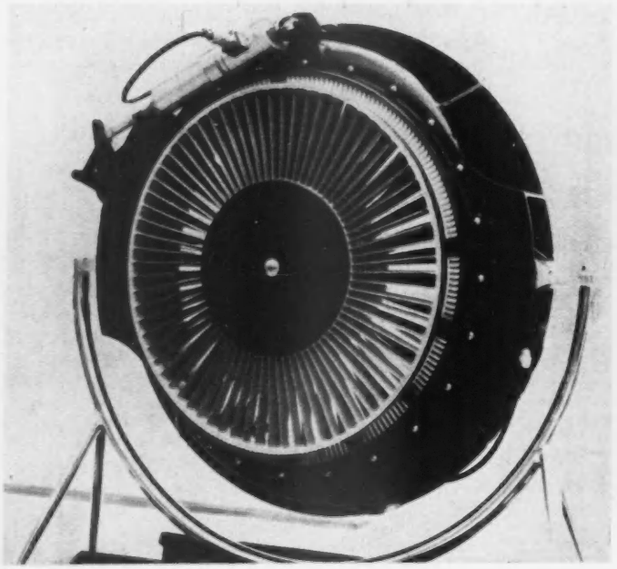
Two civil aircraft now in the design stage were exhibited in model form. The one nearer completion is the Avro 748, an intended replacement for the Douglas "Dakota," with two Rolls-Royce "Dart" engines. This machine may be regarded as a successor to the Aviation Traders' "Accountant" that flew in the 1957 exhibition, but without the "tension skin" design which uses the pressure differential to stabilise the fuselage in bending. Being essentially a passenger aircraft—although the door of the forward freight compartment is large enough

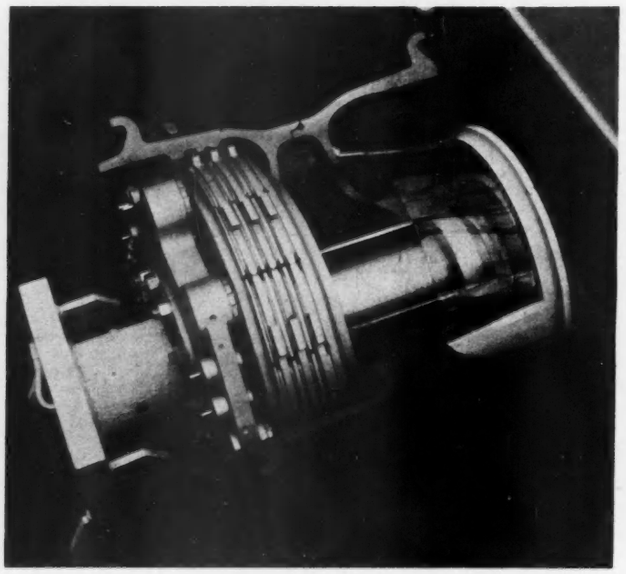


Speed capabilities of "D.H.121"

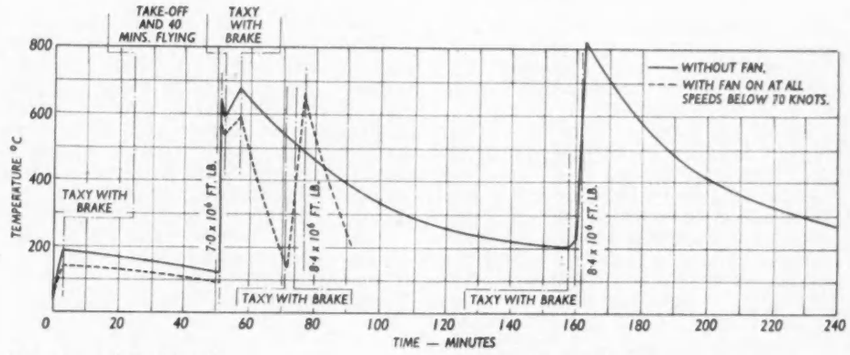
to admit a spare "Dart" power unit—the swing-nose facility is, of course, discarded. Details of the anticipated performance were given in our issue of May 8, 1959.

Revised specifications are now available for the Airco D.H. 121, on order for British European Airways. Three Rolls-Royce RB163 engines of 10,100 lb static thrust are intended to be used: since de Havilland, the originator of the design, is an advocate of buried installation even for single-sided centrifugal engines, the machine is quite unlike European and modern United States jet aircraft, being basically similar to the Martin B-51 bomber, with a nacelle each





(Left) Reaction control fan seen from downstream: the turbine blades surrounding the rotor are visible. (Right) A shrouded fan within this wheel cools the brake heat-sink



Simulated operating conditions :
1—Taxy 2 miles with brake-steering.
2—Take-off and remain airborne for forty minutes.
3—Normal brake landing.
4—Taxy 2 miles with brake-steering.
5—Wait until brake heat-sink cools to 200 deg. Cent.
6—Taxy 2 miles with brake-steering.
7—Rejected take-off stop.

Brake heat-sink temperature/time recording

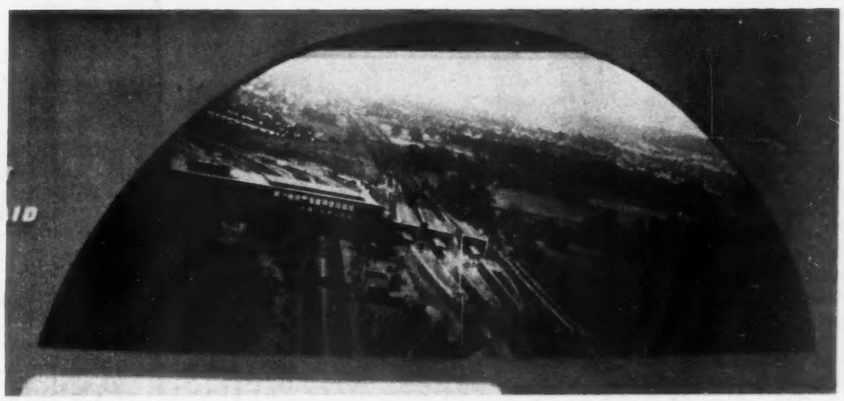
side of the fuselage and the tailplane on top of the fin. It is claimed that the D.H. 121, the maximum speed envelope of which we reproduce, will be faster than any other commercial jet aircraft : it appears that it will, in all probability, be the fastest of all short-range airliners, since the high-subsonic, ducted-fan projects are not intended for the short stages on which turbo-props are comparable in block times. Interesting features of the design are the high permissible landing weight, 100,000 lb, compared to the 105,000 lb maximum all-up weight, the asymmetrical undercarriage with nose-wheels retracting to starboard, and the proposal to use the approach coupler right down to the runway, whereas it is at present mandatory to discard it at such a height that a run-away of the autopilot can be rectified by the pilot without bringing the aircraft to ground level. The capacity payload of 21,500 lb can be flown 700 miles, or 800 miles cruising at Mach 0·8, and on a 1600-mile flight, such as London–Moscow, half this amount could be carried at the Mach 0·87 economical cruise speed.

Other machines displayed in model form were the Vickers VC–10 for British Overseas Airways, with four R-R " Conway " engines in two pods, and the Hunting H.107, for which, as for the Handley Page H.P.113, a pair of Bristol-Siddeley " Orpheus " engines are proposed.

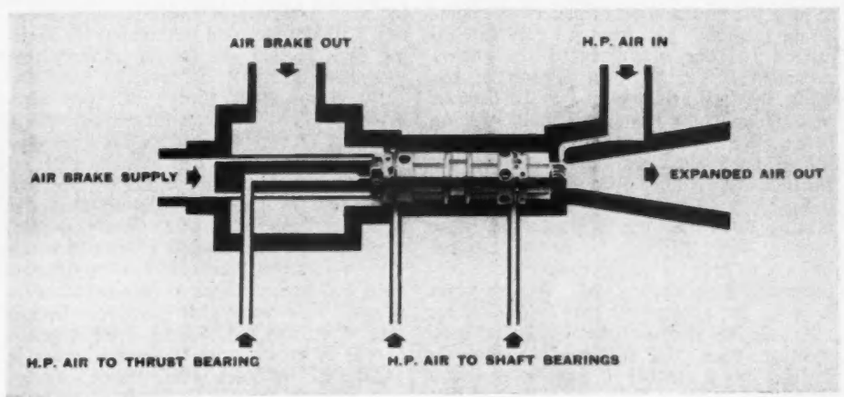
Accessories and Components

There was shown by Boulton Paul Aircraft, Ltd., a fan designed to provide control force for an aircraft in which conventional changes of geometry could not be used, a most likely instance being a machine intended to fly below stalling speed. In this application, rapid and accurate control of the force developed is essential, while power consumption must not become disproportionately high at less than full output. In the Boulton Paul design, the fan is driven by compressed air, which is available by bleed from the main engines, and turbine efficiency is maintained over a wide range of powers by resorting to partial admission. There are two air intake volutes, each with its own sector of nozzles, and the sectors can be progressively blanked off by rotating a throttle plate above them. In order that the turbine speed shall not change with torque, so that inertia effects are absent and the efficiency of expansion is high at all outputs, variable inlet guide vanes are fitted, and the control mechanism both moves the throttle plate and varies the whirl by a mechanism within the hub. Stator blades are fitted below the impeller in order to minimise the angular momentum of the air handled. The unit exhibited weighs 52 lb and gives 550 ± 150 lb thrust at 6000 r.p.m. It will be seen at once that this control fan is similar in principle to the lifting fans that have been proposed for v.t.o.l. aircraft, but in that application the power involved is very large and it is usual to apply hot gas to the turbine : this method of driving a fan should have wide application in circumstances where the fan does not have a very high utilisation.

Another proposed application for a fan was seen on the stand of Dunlop Rubber Company, Ltd., Aviation Division, in the form of a forced-cooled aircraft brake. With very slight modification to an existing wheel and brake assembly, and with a fan of remarkably low solidity, there has been effected in dynamometer trials a very great increase in the rate of cooling of the heat sink. The nest of discs is usually so closely packed into the wheel that much of the heat soaks into the surrounding components, with the risk of weakening the tyre to bursting point, vulcanising it to the rim, or degrading the hydraulic fluid in the brake mechanism. The temperatures recorded are seen in the accompanying graphs, and the decrease in the time needed for the sink to cool to 200 deg. Cent., the temperature at which another flight can be essayed, is obvious : less obvious is the fact that, in this test, the rate of cooling at any given temperature was greater after the rejected take-off ($8{\cdot}4 \times 10^6$ ft-lb) than after a normal landing (7×10^6 ft-lb). The maximum temperatures without and with the fan respectively were, for the tyre bead, 165 deg. Cent. plus 50 deg. Cent., and for the hydraulic fluid, 191 deg. Cent. and 62 deg. Cent. Only a fractional horse-power electric motor was used to drive the forced draught fan.



The image of the Zero Reader display can be seen on the windscreen : the landscape is a photograph and not at infinity

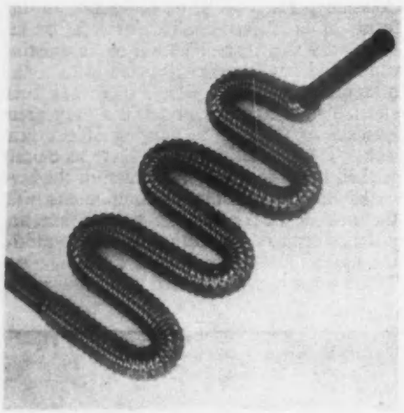


The diameter of this turbo-machine is of the order of 1in

Yet another interesting aerodynamic machine was an expansion engine exhibited by British Oxygen Gases, Ltd. This runs on air at 25 atmospheres and exhausts to 5 atmospheres, dissipating the heat abstracted from the air into a fan. The design speed of the turbine is 500,000 r.p.m. The rotor runs on air bearings and has an air thrust bearing. We are advised that the machine is by no means demanding in operation, and will run over a wide range of speeds without difficulty.

There was demonstrated by the Sperry Gyroscope Company, Ltd., a " head up " system of information presentation in which the display of a Zero Reader appears on the pilot's windscreen as if at infinity. The

Sperry flight director provides demand information to the pilot, telling him not where he is but how to get to where he wants to be, and consequently instead of needing the ability to range through 360 deg. of heading and roll it only needs to indicate a few degrees of yaw and pitch. Hence, all the information needed by at least one of the pilots of a commercial aircraft can be incorporated in the simple Zero Reader, and this display has now been incorporated in a unit with its own light source and optical system which projects an image of the indicator on to the windscreen. A collimating lens causes the image to appear at infinity, so that no change of focus of the pilot's eyes is needed to make the transition from instruments to outside references. An indicated air speed signal can be added to the visual image to assist in performing instrument approaches and landings. It is pointed out that when the aircraft is using an approach coupler and automatic flare-out, the Zero Reader can be used to monitor the progress of the landing, and since the ultimate and most important reference is the runway, the new visual flight director will greatly improve the performance of the pilot as a stand-by.



Semi-flexible tubing facilitates assembly while having greater strength than equivalent fully-flexible hose

Sperry also shows a further development of the " Introview " eddy current inspection equipment exhibited last year. This is the General Uniformity Transistorised Sampler, an inspection kit about the size of a portable radio receiver and running off a No. 8 torch battery. The probe includes a coil tuned to oscillate in the 100 kc/s band, at which the penetration of eddy currents into the material is very shallow, so that samples of varying thickness can be inspected. It is claimed that almost any non-ferrous material can be checked for variations in stress, heat treatment or homogeneity. The G.U.T.S. is, we understand, still in the development stage, and the limits of its application are not yet known.

Another item subtly different from previous exhibits was a semi-flexible tube developed by Accles and Pollock, Ltd., from the fully-flexible tube which the firm has for some time produced, and which can be manufactured in helical or annular convoluted forms. The helical type is more readily produced and permits the manufacture of long lengths ; the degree of flexibility in both forms can be controlled by varying the depth and pitch of the convolutions and the thickness of material.

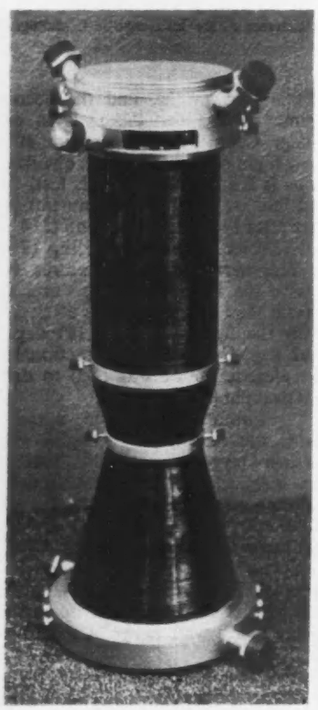
The new product is especially intended for lightweight pipework assemblies where bending or the adjustment of bends is carried out *in situ*, for example, aircraft engines. The normal practice of using pre-bent rigid tubes can prove costly and time wasting if difficult resetting is needed in the final assembly stages.

Semi-flexible tubing can be made with walls thicker than the fully flexible type to meet requirements of greater rigidity under pressure, where elongation might otherwise take place. An external braiding can be added as reinforcement for applications involving even higher pressures. At present semi-flexible tubes have been manufactured principally in austenitic stainless steel, but it can be provided in such varied materials as mild steel, titanium, and the Nimonic alloys. Sizes range from $\frac{3}{16}$in to 3in.

Another example of a product of wide application springing from the requirements of the aircraft industry was afforded by " Wadpol," shown by Valay Industries, Ltd. This is a polish intended to keep a low-drag finish on surfaces prone to oxidation, which include not only aluminium but also paint. Oxidation inhibitors as well as cleaning agents are therefore included, but the unusual feature of the product is that the chemicals are dispersed in wadding, for ease of application to vertical surfaces and to prevent accidental spillage of an expensive preparation. After rubbing the surface with the impregnated wadding, it can be polished either by hand or machine. This preparation would appear to have applications both where high gloss is necessary and where cleaning must be effected but splashing water or other liquids is unacceptable.

The rocket combustion chamber and nozzle which we illustrate was exhibited, surprisingly enough, on the stand of Bristol-Aerojet, Ltd.; it is avowedly a liquid-propellant engine, and presumably competitive with those of Bristol-Siddeley Engines, Ltd., and it is stated not to use the low-conductivity high-strength plastics materials which are a speciality of Bristol Aircraft, Ltd.

(*To be continued*)



Liquid-propellant, liquid-cooled rocket chamber and nozzle of wire-wound construction

British Association at York

No. I

We were represented editorially at a meeting of the British Association for the Advancement of Science held at York between September 2 and 9. No attempt is made in this article to summarise all or any of the very many papers of interest to engineers presented at the meeting. Instead the article consists partly of quotations from, and partly of our comments upon, a number of the papers. The intention is to suggest to the reader how mentally stimulating attendance at a B.A. meeting can be.

AN engineer should not attend one of the annual meetings of the British Association for the Advancement of Science solely to hear the presentation of papers on engineering subjects. Far from it ! He should, instead (in our view) regard the papers presented before his own Section of the whole meeting as something to be listened to only as a last resource, should nothing better offer ! The programme for any day should be studied with deep care to see whether in any other Section there is something likely to be said which may have a bearing upon engineering studies or, more broadly still, happen to be of especial interest to him for some reason quite disconnected from engineering. At this point it may be appropriate to explain—since relatively few engineers seem to attend B.A. meetings—that the whole Association is divided into a number of Sections each distinguished by one of the letters of the alphabet from A (Mathematics and Physics) to M (Agriculture) of which Section G (Engineering) is the one to which any engineer will officially belong ; plus a Section X standing for an " Assembly of Corresponding Societies." Every morning throughout the meeting each Section has two or more papers presented before it between 10 a.m. and 12.30 p.m.—about thirty each day altogether ! It often proves interesting to visit meetings of two or possibly even three or four different Sections in a single morning should the programme make it possible. This kind of perambulation is facilitated when the Association meets in a University city since the University is often able within relatively narrow bounds to provide sufficient halls and lecture rooms to accommodate the whole. One need only leave one lecture theatre at, say, 11.15 and stroll across a couple of quadrangles to reach another by 11.20. But at York where the Association met between Wednesday, September 2 and Wednesday, September 9, this year, con-

ditions in that respect were less easy. Sections A (Mathematics and Physics) and L (Education), for example, both Sections likely to have papers of interest to engineers, held meetings little short of a mile away from the Technical College at which Section G held its sessions. We, therefore, attended rather more of the Sessions of Section G than we should ordinarily expect to do. For the years lie heavier upon us than they used to ; we can no longer cover a mile in five minutes as once we could !

In the afternoons, and upon the Saturday and Sunday which intervene midway through each meeting, each section (sometimes afternoon meetings are held instead) organises its own excursions to firms or buildings or sites or places of special interest geographically, geologically, historically, &c. The Association organises others, known as "general" excursions which approximate more closely to ordinary sight-seeing. Here, again, unless Section G offers something especially exciting, it may be more interesting to join an outing of some other section. Some of the excursions of sections C (Geology) and E (Geography) which may have engineering interest, call for quite energetic exercise and the wearing of heavy boots and suitable clothing ! At the Dublin meeting a year or two ago it was even rumoured, before a coach arrived back rather late, that a whole botanical party had disappeared in an Irish bog.

In the evenings something is usually on. Each section holds a dinner or similar function at some time during the meeting. There is likely to be a concert or similar function which all members can attend. One or more notable people (not necessarily scientists) will present an "evening discourse" (there were two at York). There will be a reception, perhaps, given by the Mayor and Corporation (at York it was a garden party held in delightful weather in the Museum Gardens). Additionally every day there will be other things doing. At York, every day except Saturday and Sunday, scientific films to which the public were admitted were screened from12.15 p.m. to 6 p.m., and there were three special morning lectures named the Kelvin, Darwin and Lister lectures respectively and a further one, the Sheldon Memorial Lecture, on Saturday evening. Also, very naturally, a number of bodies in any city or town selected for a meeting of the Association set out to show themselves off in one way or another by organising exhibitions, &c., or opening their doors at special hours to members.

It will be seen that no one man can possibly do all that even his own section alone lays on for his instruction and enjoyment, let alone take part in more than a minor fraction of the activities of other sections and the general activities of members as a whole. Thus the labours of a commentator are made hard for him. Indeed one with a less elastic conscience than ours, that is one who felt himself compelled to fill every possible hour of every day with B.A. activities would leave the Meeting so worn and weary as to be long past any comment whatever !

The broad picture at any modern meeting of the Association is that of scientists and technologists presenting and discussing their findings not so much with other specialists in their own field as with scientists and technologists from other fields ; and trying also to make what they are doing intelligible and interesting to the public at large. That to a quite substantial degree they are successful in the latter object is indicated by the amount of material that gets published each year in the general press. How much cross-fertilisation arises from the former object neither we, nor we suspect any one else, is competent to assess. It must be large.

It will be rightly inferred from the foregoing that no one commentator can possibly present more than a fragmentary review of a B.A. Meeting. No attempt, therefore, will be made here to do more than to offer some reflections on activities in which we were privileged to take part and upon some of the papers presented at meetings some only of which we were able personally to attend. For an engineer the York meeting of the Association had as its especial theme "Transport and Communications" and nearly, but not quite all, the papers presented before Section G held to some facet of that subject. Thus in looking at papers presented before other sections it is with "Transport and Communications" in mind that some comment will be made. But the reader should beware. So much goes on at a B.A. Meeting that other subjects are certain to intrude. It becomes intensely desirable to be irrelevant.

The "send-off" for every British Association meeting is the presentation—usually on Wednesday evening—of the president's address. It is *de rigueur* to attend if possible, so that some very large meeting hall is needed. This year, with some misgivings, so we understand, a cinema was chosen. It proved a very successful choice. Dropping at once into irrelevance it can be remarked—though what the significance may be is in doubt—that of the various halls in which addresses, lectures and papers were delivered by far the best acoustically were the cinema and the assembly hall of a large new grammar school, both very modern products ; by far the worst the main meeting hall of the Technical College in which Section G held its more important meetings, built, we suppose, some thirty or forty years ago. Does this indicate a great advance in the science of acoustics or merely a total neglect by architects in Victorian and Edwardian days of anything so utilitarian ?

The Proper Study of Mankind is Man

This year's president, Sir James Gray, is a biologist ; and an engineer awaiting the address entitled "The Proper Study of Mankind is Man" might well have wondered what he could expect to get out of it. He was not left long in doubt. Sir James was soon saying that though Man might be regarded as Nature's supreme masterpiece he should not get too big for his "biological boots." Nor, we gathered, for his technological boots either ! "No animal can manufacture aeroplanes, Asdic or radar ; but the prize for aeronautics must go to the shearwater which navigated the Atlantic without compass or chart, while Asdic has an extremely efficient prototype in the vocal chords and ears of bats. By surrounding themselves with an electric field some fish (e.g. Gymnarchus) can detect foreign objects in the surrounding water with very remarkable precision. The total weight of the mechanism involved—including the animal's brain—amounts only to a few grammes ; a man-made instrument of comparable performance would involve at least a ton of highly complex electronic machinery." Then, harking back to a sentence that occurred early in the address—"there will always be potential danger and waste of human effort until individual nations can be persuaded to think in terms of the welfare of humanity as a whole"—Sir James pointed out that Nature has made not one, but two, great experiments in the design of social animals. He was referring, of course, to the social insects, notably the ants ; and at least one of the social habits of ants is deplorable. They have engaged in global warfare. "Early in the nineteenth century an Eastern species having spread rapidly over North Africa and South Europe, managed to reach the islands of Madeira and Bermuda ; in both places it exterminated the smaller native races. Meanwhile a similar policy of territorial expansion had been carried out by another species from the Argentine which, having landed at New Orleans, very rapidly over-ran the southern United States ; in due course it, too, reached Bermuda, where it proceeded to eliminate the earlier invader." Commented Sir James, "men really ought to be able to do something better than ants."

Another subject to which Sir James gave attention arose out of a remark early in the address that the discoveries of physics have frightened mankind—we shall revert to that subject when we come to consider later some of the proceedings of Section X. Sir James clearly felt—and in our view surely rightly—that Science would be less frightening to the uninformed if it were better wedded to the "humanities." He himself wished that he could have been trained in youth to think dispassionately about social and political affairs as well as scientific ones, and that he could have been taught to appreciate beautiful things. But could he have acquired this knowledge, he asked, whilst training as a scientist ? He rather concluded not. For ourselves, we rather conclude the other way. It is, of course, a fair comment that there simply is not room in a scientific or technological university course for "humanist" studies. But the argument that a student cannot be expected to study for more than a certain quite small maximum number of hours a day is surely nonsense. One of the marks of intelligence in a young man is a persistent interest throughout all waking hours in what goes on around him or in the minds of those he talks to. Provided only that a variety of experience is offered the human mind seems quite tireless. If that is so is it so certain that a science student supposedly fatigued by six to eight hours' scientific instruction during the day is incapable of appreciating the arts in the evening ? One other thought thrown out by Sir James especially caught our attention. "A democratic society," he said, "has to decide how much of its total educational effort should be devoted to an ever-increasing standard of living and how much to raising the intellectual standards whereby the majority of the population forms its judgments on matters which are susceptible to personal prejudice or political propaganda." Surely, he seems to be suggesting, it is an arid object of human advance and not really conducive to happiness to condemn men to that kind of egotistical competition we term "keeping up with the Jones's." Indeed, it may be, it seems to us, that here can be found some of the seeds of war. Instead Sir James pleads for a more intelligent approach to life by which each individual assesses what will best satisfy his own needs and desires, takes an intelligent interest in other men's solutions to their problems, and seeks sensible conclusions wherever joint efforts must be made or human desires appear conflicting. A recent inquiry, Sir James suggested, "indicates relatively clearly that the attitude of mind of an individual towards a changing environment is directly related to the nature and extent of his full-time education and that it is this training which largely determines, in later life, his response to other potential sources of education—such as libraries and

broadcasts," and, no doubt, museums, art galleries, literature and the theatre, too.

Transport and Communications

Let us turn to "Transport and Communications." Chronologically to refer at this point to the Address of Sir Ewart Smith to Section G is out of order. For the Address was delivered not on Thursday morning as planned but on the Friday. Yet it set the tune for Section G. We have reprinted it, almost in full so that there is little need to make much reference to it here. It is characteristic of Sir Ewart. He sees that as compared with the mid-nineteenth century when Britain had the best transport system in the world it has since applied neither the technology nor the money to keep up with advances taking place elsewhere. He shows that it is critically important for this country to have a really up-to-date transport system and with impatient vigour he urges on the rebuilding of the whole. Between 1830 and 1850 new railway routes were being built in Britain at an average rate of 320 miles a year. That is to be compared with Britain's post-war achievement in building motorways of only 64 miles by the end of this year. And for good balanced measure is not bolder thinking needed on the railways too ? Should not wagons of greater capacity than those planned be used ? Cannot turn-round time be reduced even more than as planned ?

We do not intend to mention each and every paper presented before Section G ; for to do so would be to limit the attention we could give in the space available to activities elsewhere. On the whole engineers in presenting papers before Section G followed their President's example and made no undue claims for the virtues of either road or rail. Like Mr. Kerensky who spoke on the relatively innocuous subject of bridges they kept a due balance. Mr. Kerensky pointed out that one of the more important tasks is to assess the type and frequency of loadings to which old and new bridges will be subjected during the next 100 years. For railway bridges this means analysing the possible changes that railway modernisation will bring. For highway bridges the engineers have got somehow to guess at future trends in vehicle design and use. All rather trite? Yes ; but Mr. Kerensky added that the recent trial flights of the Saunders-Roe "Hovercraft" does not make that task of engineers any easier. That is not so trite !

But when the economists got busy on the subject things were different. Dr. Charlesworth and Messrs. Reynolds and Wardrop did much the usual thing in a paper on "Road Traffic and Economics." They estimated that road users in Great Britain spent about £3000 million on road vehicles and their uses in 1958, of which £500 million represented licence duties and tax on fuel and on new vehicles. They estimated that there will be about twice the present amount of traffic on the roads in ten years' time and that the cost of congestion at present amounts to about 10 per cent of road transport costs. Then a method of estimating benefits to be expected from roadworks was put forward which might act as a yardstick by which priorities could be determined. But this turned out to be all rather small-beer compared to a lengthy paper actually presented at the meeting only in summary, but which lies before us in full as we write, on "Economics of Transport" by Sir Reginald Wilson. We intend to print a summary of this paper and we recommend readers to read the whole document when it is published by the Association. As Sir Reginald is Chairman of the Eastern Area Board of British Railways one expects to find his analysis more favourable to railways than much that is published nowadays. We do not doubt the accountancy which concludes on a "like for like" calculation that road vehicles are paying less for their tracks than the railways ; on Sir Reginald's figures we cannot doubt it. But if the banner "Unfair to Railways" is raised on that basis (Sir Reginald does not directly raise it) we doubt the validity of the argument. No certain truth has come out of the many speciously convincing economic and accountancy arguments relating to road and rail. Nor are Sir Reginald's arguments wholly convincing either. So we can agree with him that ultimate policy on the road-rail question is "more a matter of art than science" and we should like to agree with him that "there will be no wise policy which is not based on a scientific approach to the facts." The trouble, despite a wealth of statistics, is to determine the facts ! In the circumstances we find ourselves for once grateful for the existence of politicians. For politicians are men who study, not the full facts nor what, upon some scientific, economic or other fundamental principle, ought to be done. A politician decides merely what at any time it is possible to do, provided (presumably) his party will not be handicapped at the next election by doing it. On that basis two things are possible in transport. Because the number of vehicles on the roads is expanding very fast and because a large number of people are employed directly and indirectly in making and maintaining vehicles and making and maintaining roads it is not only electorally possible but electorally desirable that a lot of public money should be spent on new motorways, and upon urban improvements. Equally it is not electorally possible to lay new burdens of taxation upon road transport. Curiously enough, for the railways, electoral possibility goes rather otherwise. Railway modernisation is certainly desirable electorally. But the closing down of branch lines is objectionable only to the few ; the many hope thereby to see railway freight and passenger costs reduced.

Sir Reginald placed, however, a finger upon a sore spot that may trouble the social conscience. For how individual can we afford to be ? If the motor-car is used for a large fraction of private travel and the "C" licence vehicle for the carriage of freight, what happens to the public vehicles maintaining regular timed services ? The individual owner of a vehicle can usually operate it so as to be more than competitive, or at least to seem more than competitive, with any public service vehicle, just because he can choose to operate it only when it is profitable to do so or only upon the more paying routes. The public operator can then barely compete on the more profitable routes, far less earn sufficient to maintain services upon unprofitable routes. Who, then, provides a service for those members of the community who are insufficiently wealthy to own private passenger transport and have too little goods to send around to justify the operation of a "C" licensed vehicle ? Those with longer memories will recall that the advent of "pirate" buses, many individually owned, upon London's streets was a prime cause of the setting-up of London Transport. The "pirates" were ruining the London General Omnibus Company by operating only upon the more profitable routes. If surface passenger transport in London was not to be dislocated, something had to be done.

Instead of mentioning other papers in Section G we shall straightway jump to Section J (Psychology) and listen to Mr. Poulton talking about "Fatigue and Boredom in an Inspection Task." There is relevance to road transport. An experiment, which was carried out in a laboratory, he said, suggested that an industrial inspection task imposing a medium mental load might deteriorate less with time than tasks imposing either greater or smaller loads. The deterioration with a greater mental load could perhaps be attributed to "mental fatigue," while the deterioration with a smaller load might be attributed to "boredom." The task with a medium mental load would presumably keep the man's mind adequately occupied, without giving him too much to do. The author suggested that added incentives, whether in the form of money or threat of prosecution, were not likely to improve performance much in the vigilance tasks. There is, we suggest, much relevance there to road transport. Is there not much "mental fatigue" derivable from driving a vehicle along badly designed roads ; equally, cannot "boredom" intervene upon an autobahn ? If so, those who hope to reduce accidents upon the road by imposing more and more savage penalties upon those held to be driving dangerously should pay attention to Mr. Poulton's conclusion already quoted, and his further one that "the solution lies in redesigning the job," which means, we suppose, in our context, designing the roads to suit human beings instead of trying to force human beings to fit the roads.

Still sticking to transport, listen to Professor Edwards addressing Section E (Geography) on "Trends in Urban Expansion."

"The latest phase of urban expansion is directly related to the development of motor transport. It is motor transport which directly or indirectly accounts for much of the economic and social activity of the present-day city, and it is largely the motor vehicle which has determined the nature and form of recent city extension. It has permitted the dispersal of industry and the spread of residential areas, yet it has also been the means of increasing the importance of commercial and service functions at the centre. Its effect is at once centrifugal and centripetal. These opposing forces tend progressively to produce extreme conditions, those of intense congestion at the centre and unmitigated sprawl on the outskirts. The control over urban growth now exercised by transport is so great that doubts arise as to the future capacity of the city to discharge its normal functions satisfactorily. Will the great city disintegrate ? Not long ago Dr. Colin Clark discussed some aspects of this dilemma in an article to which he gave the eloquent title, 'Transport—Maker and Breaker of Cities.' His conclusion that motor transport, despite its economic efficiency, leads to the formation of urban communities, which are in many respects socially undesirable, is clearly justified, but this need not evoke an attitude of Spenglerian gloom as if it portended irrevocable failure on the part of urban society. The problem is really one of physical planning and of improved urban organisation through a more rational system of administration. The need for action is undeniably urgent, for the forces making for urban expansion and the scale upon which they are now operating cannot be halted." In the last year or two we have repeatedly pleaded for collaboration between engineers and architects in the planning and construction of urban motorways. We seem to have been talking wisely.

(*To be continued*)

The Critical Importance of Transport and Communications

By SIR EWART SMITH, F.R.S.

No. II—(*Concluded from page* 219, *September* 11)

In this, his Presidential Address to Section G of the British Association for the Advancement of Science, presented on September 3 before the meeting of that Association in York, Sir Ewart pleads, in effect, for more energetic and forceful policies for the improvement of land transport in this country. He shows that, whereas we were leading the world 100 years ago, we have since then fallen behind several other countries. On the roads attention needs to be given to urban transport and on the railways, especially to freight transport in larger (and fewer) wagons than are at present contemplated. He concludes : " We must redress the balance by far more capital development, particularly of the road system, and by training a greater proportion of our best minds in the understanding and use of science for this as for other purposes."

At this point it may be useful to examine briefly what other countries are doing—some of them with economies far poorer than our own. The following table gives data for 1958 based on a report by the International Road Federation[2] :—

	All motor vehicles except cycles, millions	Total road expenditure, million £	Expenditure per vehicle, £	Expenditure per inhabitant, £	Private cars per 100 inhabitants[3], 1956
Australia	2·38	97	40	10·0	17
Austria	0·43	39	90	5·6	—
Canada	4·41	382	87	23·0	20
France	5·20	237	46	5·4	8
Western Germany	4·27	382	89	7·4	4
Great Britain	5·48	136	25	2·7	8
Holland	0·57	19	33	1·7	—
Sweden	0·99	54	55	7·4	10
U.S.A.	68·40	3540	52	21·0	33

If we consider motorways in their proper concept as reserved for motor vehicles, having dual carriageways and with access only from two-level flyovers or underpasses, Great Britain will, by the year-end, have a total of 64 miles. West Germany already has nearly 1500 miles and plans another 1300 within ten years at a cost of £2000 million. In spite of her small size, even Holland has some 200 miles of motorways completed, and France, with a fine system of existing roads by British standards, has plans for more than 1000 miles. Italy already has an extensive system of motorways and is now extending them in spite of difficulties of terrain and a lack of economic resources that far exceed our own.

No really major bridge has been built in this country for twenty-five years, if we except the replacement of Waterloo Bridge, which hardly comes in that category. We are at last moving on road bridges for the Firth of Forth, for the Severn, and, on a lesser scale, the Runcorn–Widnes link, but France has already opened the Seine bridge at Tancarville, with a span of nearly 2000ft. It has a capacity of 20,000 vehicles per day and cost nearly £6,000,000, but in the first three weeks tolls brought in £37,000. Brunel's remarkable railway bridge at Saltash is 100 years old, and even then he wished to make it a road bridge as well ; once again, there is talk of this link between Devon and Cornwall, but how long will it be before it comes into being ?

No less than 60 per cent of British trunk roads now carry traffic in excess of their designed capacity, and the load is growing at about 7 per cent per annum.[1] But even so, the crucial limitations to traffic flow lie in the towns rather than on the interconnecting trunk roads, yet so far it is improvements to the latter that have had priority in time and capital. The future plans that have recently been announced do nothing to improve the balance in this respect. It must be remembered that, although the urban average speed is 20 m.p.h., the figure for central London is 10 m.p.h., central Glasgow 8 m.p.h., and Edinburgh 13 m.p.h.

It is true that the rate of increase in London traffic falls well below the national average, due no doubt to the extreme congestion. But it would hardly seem wise to limit traffic growth by making conditions so bad that what now exists can barely move ! While other great conurbations like New York and Los Angeles may not have solved their own serious difficulties, they have tackled them with a boldness and vigour that has been absent here. They have dealt with them by major engineering works, often of a most imaginative kind. The civil engineers of this country could do the same, if there were the same clear call to action, the same comprehensive approach, and the same realisation that the work must be done, preferably before, rather than after, the traffic gums up.

Since this paper was commenced, the Ministry of Transport has announced the Government's intention of spending not less than £60,000,000 per annum on major road works, and £6,000,000 per annum on improvements in London.[4] While this is a step in the right direction, it must be considered far too small when judged against the sheer needs of the situation and the relative savings to be made. It is clear that our present scale of effort will, in fact, lead us to increasing loss ; this may be hidden in the national balance sheet, but it is no less real and is something we can no longer afford.

With taxation at present levels there is natural and proper reluctance to provide additional capital from current income, but it is for consideration whether the user of major new facilities should not directly service the capital required. Many other countries charge tolls for motorways, bridges and tunnels, as has been done with success for the Mersey tunnel. Motorists would properly press for the abolition of such charges as soon as the community is rich enough to absorb them. Meanwhile, they would have the alternative of the older routes.

Railways

The 1958 report of the British Transport Commission and the White Paper published in July show what marked progress is now being made on the technical side in re-equipment and modernisation, and managerially in the application of the more modern techniques of management. Except to learn for the future, it is fruitless to regret the past and how little was done during the first half of this century, but I cannot forbear to point out that this period coincided with the failure to recruit for the railways more than a handful of well-trained technologists or of university graduates from other disciplines. As late as 1956, the British Transport Commission employed only 1551 professionally qualified scientists and engineers, or 0·23 per cent of their total employees.[5] In comparison, the Coal Board had 0·7 per cent, the Central Electricity Authority 2·9 per cent, and the Atomic Energy Authority 10·9 per cent. The effect of this past attitude to recruitment must be a serious drawback for a long time to come, and must make the work of modernisation slower and more difficult than it should be by modern standards. With a more vigorous technological approach in the past, the size of such an expensive " crash " programme would have been greatly reduced. One cannot but be aware of the different attitude that has existed and the striking technical advance that has been made on the Continent—particularly in France—and in America. In these countries, university trained engineers have not only been recruited in greater measure, but many of them have been used on the managerial and operating sides up to the highest levels, as well as on design, construction and maintenance.

We can sympathise with railway managements everywhere on their competitive difficulties in face of both road and air transport. Nevertheless, it cannot seriously be argued that we could do without the railways for our heavy freight and much of our passenger traffic. As engineers, we can appreciate, too, the great difficulties of track modernisation while the lines have to be kept in regular use. The question is, are we moving fast enough with existing schemes, and are we even yet thinking with sufficient boldness in the technical sphere ? It is true that we have at long last decided to abolish the steam locomotive and to order no more, but even by 1947, 98 per cent of all main line locomotives being built for the U.S. Railways were diesel-electric. From the start of the railways until a few years ago we clung, after everyone else, to the chaired bull head rail, though the *raison d'être*—that it could be reversed when worn—was quickly found to be unsound. Now the continuously welded rail has been proven, and has real advantages in smooth riding and reduction of wear and tear, but here also we are behind others in rapidly following it up ; France, for example, already had 1000 miles of such track by 1955. This type of rail is best used with concrete sleepers, but this should also be to our advantage, for concrete is indigenous and permanent, while timber is not. Then, again, we have only recently accepted the policy of mechanical brakes for all wagons, long after this was standard practice abroad ; in doing so, we have kept to vacuum brakes, although pressure-operated brakes have much to commend them from the technical angle and are normal elsewhere. I quote these examples

not in any spirit of recrimination for past mistakes, for which we all carry a share of responsibility, nor in criticism of those presently in charge, but to disarm those who always advance objections to any change, to encourage support for the Transport Commission in their present efforts, and to appeal for still bolder policies in the future. What has to be done requires the active help and support of the "users" in addition to the steps that the Commission are taking. The users must be prepared where necessary to change their own methods and equipment so that the full potential benefits may be obtained. In this it would seem that the Commission, and indeed the Government behind them, must give a clearer lead at the highest level if results are to be achieved in reasonable time.

I would mention a few points that seem to be of particular importance in relation to the crucial problem of road competition, especially for freight traffic.

Figures recently published show that for the total ton-miles of inland transport in 1952, the railways carried 54 per cent and the roads 46 per cent; in 1958, the position was more than reversed, for in that year the railways carried only 44 per cent.[6] The obvious reasons for this change are cost, convenience in door-to-door service, and usually in speed. On the last point, the railway Regions are developing express freight trains and scheduled freight working, and in 1958 35 per cent of freight train mileage was in brake-fitted trains, against 29 per cent in 1957.[7] Although most of these trains ran to stated timetables, by contrast more than 80 per cent of German freight trains work to published schedules, irrespective of the traffic offering. But it is in effective use of wagons that British Railways has the greatest leeway to make up. A broad guide to usage efficiency is given by dividing the total number of loaded wagon despatches per annum into the total number of wagon-days in the year. On this basis, the average time of wagon turn-round in 1957 was[8]:

Great Britain	12·9 days
France	9·4 days
West Germany	5·5 days

In 1958, British Railways owned some 1,060,000 freight vehicles, and the total distance run (loaded and empty) was 3505 million miles.[7] Thus, on average, each British wagon ran less than 3500 miles in the year, or roughly 10 miles per day. For expensive vehicles to achieve a functional speed of well under ½ mile per hour is not impressive. If "C" licence road vehicles were similarly used, there would be few of them indeed! In fact, those over 5 tons average 26,000 miles per annum, or more than seven times as much as rail wagons, in spite of the hauls being shorter.

Of course, much of a wagon's time is spent at the loading and unloading points, often outside the railway's control, but that is where the policy on demurrage charges needs to be bold, not least in the long-term interests of the users themselves. If valuable mobile storage is required, it must be paid for, but quicker turn-round would do much to reduce basic rates.

If average turn-round were brought down to even six days—and what other countries with similar economies can do should be possible here—the total number of wagons might be reduced to under 500,000, with a tremendous saving in overhead charges, in operating costs, and in the fitting of brakes to existing wagons. It must be noted that the German results stem not only from action by the railways but also from a much more active technical and managerial approach by German industry. It was good to see that in 1958 the wagons in use declined by over 100,000, but the present target of 750,000 wagons in 1963[9] still seems unduly high.

But there is a further important matter in the size of standard wagons for bulk loads, such as coal, minerals, heavy chemicals, &c. Such traffic represents over 70 per cent of the tonnage handled, but the average wagon load is only 12 to 13 tons. Other countries have larger standard wagons and carry heavier unit loads, e.g. in Germany the average wagon capacity is 21 tons, as against our figure of 15 tons. While some small wagons are desirable, there must be something peculiar in the British atmosphere—physical or mental—if wagons larger than the present standard of 16 tons, or even the tentative 20/21-ton type, could not be used with great advantage for traffic of this kind. The gain would not be just to British Railways, but to the larger users also, once their sidings were equipped to handle them. Of course, the full implementation of such a plan would take time, and would involve the use of bogie wagons, but unless the policy with regard to future maximum dimensions and capacity is fixed and declared, there will always be the plea, as from the Coal Board, that the despatchers or receivers cannot take larger wagons with their existing facilities. Clearly, our loading gauge prevents the possibility of the 80 or 100-ton monsters in use in North America, but a 35–45-ton load might ultimately well be used for at least 50 per cent by weight of all freight traffic. I know of a case where 40-ton (roller bearing) bogie wagons have long been in regular use, handling up to 1,500,000 tons of limestone per annum on a round trip of 72 miles, with an achieved annual average fleet turn-round from loading to reloading of thirty-two hours. In this case, the user was both despatcher and receiver, and has gained great benefit from this service in comparison with the former use of small wagons and normal methods. The steel industry is doing much along similar lines with great success, because it, also, is often both despatcher and receiver, and because it has the technical competence and resources to tackle such problems in a big way. But can the same be said of coal, where until the recent development of competition from other fuels, the producer had no interest in transport beyond getting the product away from the pithead?

Unless the railways take advantage of their unique potential for heavy unit loads and regular service, their decline will continue. They are making valiant efforts, but, in my view, still have their sights too low with regard to size and turn-round, and to stimulating corresponding action by those who despatch and receive. It is ironic that at this time of decline in the coal trade, the first mechanical unit for handling domestic coal should have recently been opened in London. In the U.S.A., such installations have been common for many decades, one might almost say invariable, in every centre using coal in any quantity.

Where freight cannot go through private sidings, recent developments of containers show great possibilities; to this the Transport Commission is fully alive, but here again, there seems less drive for a national approach on standards and for co-operative working, than is evident elsewhere, particularly in the U.S.A. There the railways face still greater competition, but even so they have survived without State aid. It is certain that they have only been able to do so by the utmost vigour of technical and organisational development. But, of course, they have long regarded rail transport primarily as a matter of engineering, whereas we ceased to do so nearly a hundred years ago, once our rail system had been completed; we are now only just getting back to that idea. I use the word "engineering" in the widest sense to include the scientific analysis and development of traffic schedules, no less than the investigation of a bridging problem, whether in its general concept or detailed stressing. Both demand the same type of mind, similar analytic methods of approach, and even some of the "tools" to be used, such as computers, are similar if not actually the same.

Wages and salaries account for some two-thirds of all railway costs, thus the effective output per person employed is a crucial test of productive efficiency. Measurement of "productivity" is beset by many difficulties, and absolute comparisons can be misleading and unfair. Nevertheless, the objections do not apply so strongly to a broad comparison of trends, if a reasonable yardstick of output can be found. The units of passenger-mile and ton-mile are available and convenient for this purpose. In terms of cost they are similar and do not fluctuate rapidly from year to year; thus, their totals can be added and divided by the total manpower to give a broad relative measure of progress over a period of years.

	Passenger-miles plus ton-miles per employee[10]		
	British Railways	French S.N.C.F.	West Germany
1938	$6{\cdot}6\times10^4$	—	—
1949	$6{\cdot}9\times10^4$	$8{\cdot}1\times10^4$	$8{\cdot}9\times10^4$
1950	$7{\cdot}0\times10^4$	$9{\cdot}2\times10^4$	$9{\cdot}2\times10^4$
1951	$7{\cdot}3\times10^4$	$10{\cdot}7\times10^4$	$10{\cdot}1\times10^4$
1952	$7{\cdot}2\times10^4$	$11{\cdot}0\times10^4$	$10{\cdot}1\times10^4$
1953	$7{\cdot}3\times10^4$	$10{\cdot}2\times10^4$	$10{\cdot}1\times10^4$
1954	$7{\cdot}4\times10^4$	$11{\cdot}0\times10^4$	$11{\cdot}2\times10^4$
1955	$7{\cdot}4\times10^4$	$12{\cdot}5\times10^4$	$11{\cdot}3\times10^4$
1956	$7{\cdot}5\times10^4$	$13{\cdot}7\times10^4$	$11{\cdot}7\times10^4$
1957	$7{\cdot}6\times10^4$	$14{\cdot}4\times10^4$	$11{\cdot}7\times10^4$

These figures must not be pressed too far, but the disparity is great, not least in regard to the long-term rate of improvement achieved. The destruction of the French railway system during the war gave the opportunity there for bold developments and striking results as shown by the above table. As the technical work of modernisation becomes effective, we shall certainly see a rapid rate of advance by British Railways. It must never be forgotten that our present difficulties largely exist because for many years capital on a proper scale was not available to the railways; before nationalisation, owing to the enforced system of rates and charges, and more recently, as a result of the Government's economic policy. Now that action has been started, there must be no hesitation in driving it through.

Conclusion

It is natural to compare a national community in its development and functions to the human organism. The analogy is close, whether one considers the early stages of growth with its increasing complexity and the rise of consciousness, or compares the muscular system of the individual with the industrial sources of power. Transport clearly corresponds to the circulation of the blood, as we recognise when speaking of "arterial" roads; similarly, the body's nervous system has its counterpart in "communications," if that word is used in its fuller meaning. How far human ageing and death is normally due to loss of tone in the circulatory system it is for the medical scientists to say, but even the layman knows that arterio-sclerosis and thrombosis are deadly dangers; so, too, are the corresponding diseases of transport. But here there is

indeed a difference between the human and the corporate body. The latter has it within its own power to renew and develop its transport systems indefinitely to ensure healthy existence and, if desirable, growth to the limits of geographic space.

Since the last war we have done much to extend our industrial resources for the production, as it were, of new tissue and increased blood supply for the body politic. My argument is that the development of our land transport system has, relatively, fallen far short of our needs. In consequence, the whole body suffers a loss of time and efficiency. This is a condition we cannot afford in a competitive world, and one that we should not tolerate for the sake of our pride or our comfort. We must redress the balance by far more capital development, particularly of the road system, and by training a greater proportion of our best minds in the understanding and use of science for this as for other purposes.

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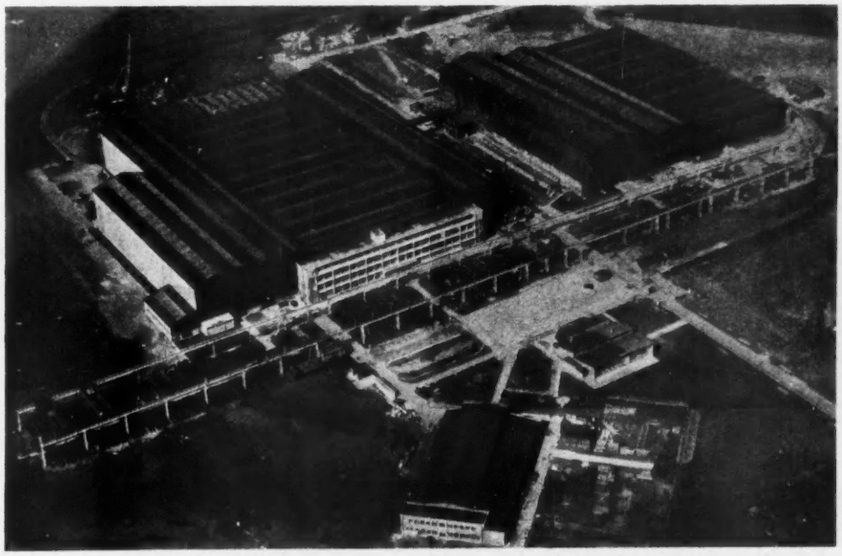
South Works of the Power Gas Corporation, Ltd.

The construction programme for the new South Works of the Power Gas Corporation, Ltd., and Ashmore, Benson, Pease and Co., at Stockton-on-Tees, has now been completed. This works, which is built on a 125-acre site, has been designed and equipped for the manufacture of large plant and vessels of all kinds for the iron and steel, gas, chemical, oil and other industries. The layout of the new buildings can be seen in the aerial view of the works.



THE fourth stage in the new works construction programme, started in 1949 by the Power Gas Corporation and Ashmore, Benson, Pease and Co., Ltd., at Stockton-on-Tees, was recently completed when full production was started in new light and medium machine bays and extensions to a heavy machine bay. This new works scheme, it should be recalled, was evolved when, in 1948, it became evident that the existing Parkfield works had been developed to a stage where no further extension or equipment modernisation could be undertaken to meet the envisaged demands for larger and heavier plant for the iron and steel, gas, oil, chemical and other industries. Neither was it possible to install in the existing shops large new machining capacity required, or start new departments to take advantage of improved processes and materials which were being developed.

In the first stage of the programme a site of about 125 acres was acquired half a mile south of the Parkfield works and a new constructional shop with a productive area of 132,000 square feet built. This shop, which was opened in August, 1951, consisted of four 85ft wide, 250ft long transverse bays with a 65ft wide, 340ft long bay extending along the full length at each end. The transverse bays have a height of 30ft to the crane tracks and are generally used for producing component parts which are assembled in the longitudinal bays, which are 50ft high to the crane tracks. In the next stage of the programme two further transverse bays were added and the longitudinal bays extended to a length of 520ft. In the same part of the programme the first bay of a new heavy machine shop, 250ft long and 100ft wide over crane rails, was built and equipped. This stage was completed in 1955 and it increased the new works productive area to 230,000 square feet. Details of the new buildings and their equipment at this time were given in an article in THE ENGINEER of July 29, 1955.

Under the fourth stage of the programme just completed, the 250ft long heavy machine shop has been extended by 150ft, and at one side along its full 400ft length there has been built a new medium machine bay 100ft wide with a height of 35ft to the crane rails. On the further side of this medium bay there has been erected a 400ft long, 170ft wide light machine bay which incorporates a tool room and a stores. A new 80ft wide, 340ft long high bay has also been added to the side of one of the longitudinal bays of the fabricating shop. These additions have brought the productive area of the new works up to a total of 377,200 square feet, and the main structure of each shop is designed to permit future extensions without interfering with production. A 1165ft long stockyard, which runs along the full length at one end of the main buildings, is served by two 10 tons capacity, 80ft span overhead cranes, and from this yard rail bogies carry materials straight into the shops. Spur tracks from the works railway system extend into all of the bays, with the exception of the light machine shop, and these tracks are used for the transfer of heavy parts on rail bogies between the main production sections.

In a works of this kind, where large complete plants are made to individual designs, most components are "one off" and there is little or no batch production. For this reason the initial layout and equipment of machine shops involved a number of problems in determining the types, sizes and arrangement of machine tools to ensure adequate capacity, efficient machine loading, and economic usage. Therefore, before the final plans for the new machine shops were decided upon, a number of alternative schemes were examined and an extensive study made of the facilities and services based upon experience in the Parkfield works. These studies and the use of models enabled decisions to be reached to ensure for the new shops the provision of adequate machining capacity, means of efficient machine utilisation, the reduction of materials handling to a minimum, and to give a degree of flexibility in layout which would provide for future requirements. Under the main scheme evolved, work generally weighing up to 5 tons is handled in the light machine bay, up to 25 tons in the medium bay, and above 25 tons in the heavy bay. We reproduce on page 260 photographs of the new machine shops and also a drawing which shows a cross section of their structure. Many of the machines installed in the new shops have been transferred from Parkfield works and most of the new machines introduced have been selected to increase the capacity for larger and heavier components.

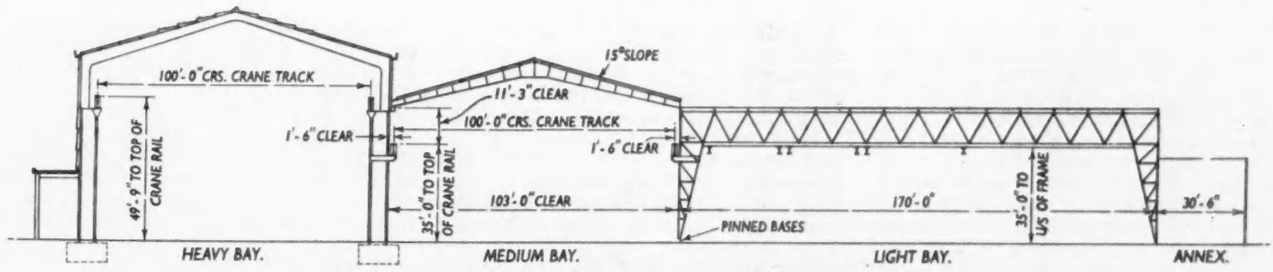
In the medium and light machine shops, the general flow of work starts from a storage area adjoining marking-out tables at the stockyard end. From this point the machines are grouped down the length of the shop in accordance with the natural operating sequence which is followed in the production of parts, an arrangement which ensures that the distance of work transfer between machines is kept to a minimum. The materials in process thus flow in one direction down the shops, to be finally delivered to inspection and assembly areas at the dispatch end. Structurally, the new light machine bay is of interest in that it provides an unobstructed floor area 400ft long by 170ft wide. The central 150ft width of the shop over its full length is served by a system of 5-ton overhead suspension cranes. This clear floor area will give a wide measure of flexibility for the movement

South Works of the Power Gas Corporation, Ltd.

The main machine bays of the new South Works of the Power Gas Corporation, Ltd., which are illustrated on this page, comprise a light machine bay for work weighing up to 5 tons, a medium machine bay for work from 5 to 25 tons and a heavy bay for machining work of over 25 tons. The 400ft long heavy machine bay to be seen on the RIGHT is 100ft wide over its crane rails, which are set some 50ft above floor level and carry two 50-ton cranes. Its equipment includes a 23ft diameter faceplate lathe, a 10ft by 8ft planer with a 35ft tandem table for 100-ton workpieces, a 7in ram horizontal borer and a 20ft 8in diameter vertical boring machine.

The medium machine bay is also 400ft long and 100ft wide over the crane rails, which are set 35ft above floor level and carry a 25 ton and a 15 ton capacity cranes. The illustration on the LEFT shows the machine end of this shop and at its lower end there is a large assembly area which provides facilities for the erection of rail-mounted equipment such as slag and hot-metal ladles, scale cars, &c. It will be seen in these two illustrations that in both the heavy and the medium bays the machines are installed down either side to leave a clear central area for work transfer and the accommodation of components between operations. In the medium bay, as in the light machine bay shown on the RIGHT BELOW, the general flow of work is from a storage area at the top end, down through machines arranged in accordance with the natural operating sequence to an assembly or dispatch area at the lower end of the shop.

The photograph of the light machine bay was taken from about midway along the shop and looking towards the top of the machine lines. It gives a clear impression of how the method of construction adopted has provided an unobstructed floor area 170ft wide. In this structure nine braced portal frames of box design are connected down the full 400ft length of the building by eight girders which support the rails of the overhead crane system. The transverse tracks on which the crane crabs run can be latched together in line to enable loads to be traversed across the full width of the shop. An enclosure to be seen on the top right-hand corner of the shop contains the main toolroom serving the three machine shops, and a space partitioned off on the left-hand side is used as a stores area.



Typical cross section of machine shops at the works of Power Gas Corporation

of machines when introducing new plant, and it facilitates the routeing of materials and component parts from a stores extending down the full length on the outer side of the shop. The roof structure is carried by nine braced portal frames of welded design, in which the main members are arranged in pairs to provide rigid box structures. These nine main box frames are connected down the full length of the building by eight girders which support the rails of the overhead cranes through suspension links.

The crane installation suspended from the main structure by these flexible links was supplied by Demag A.G., and can be seen in one of the illustrations. Each crane assembly comprises a 5-ton capacity crab which traverses along a twin beam track supported at each end through an eight-wheeled carriage on the main longitudinal rails. A point of interest in the design of the transverse crane tracks is that they can be aligned across the width of the shop and linked together by latches. This enables any required number of tracks to be aligned and a crab, complete with a load, traversed across the full width of the shop to facilitate movements without need for transferring loads from crane to crane or on bogies.

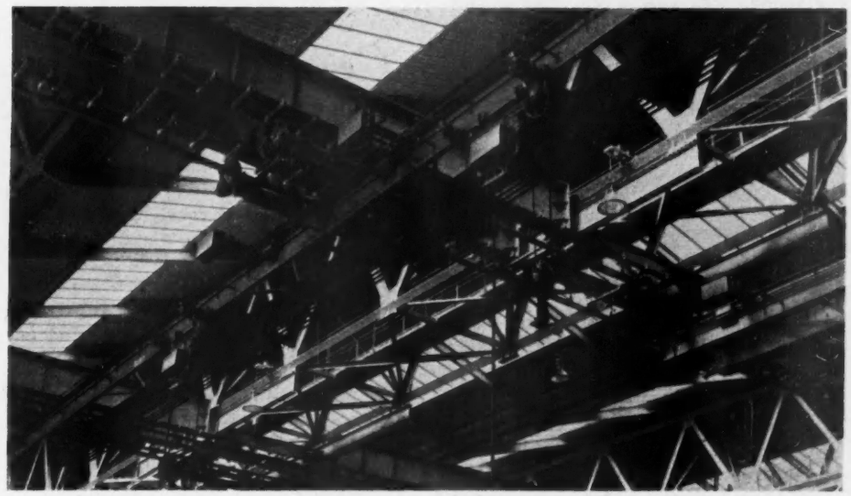
The crane rails down one side of the shop carry three 30ft span cranes. Two central sets of rails each carry two 40ft span cranes and, in addition, a crane of 80ft span runs on both sets of rails. The remaining track over the stores area is served by a single 40ft span crane. With the exception of that with an 80ft span, all the cranes have been fitted with pendant floor control gear, although they can, when required, be provided with overhead cab control equipment. The 80ft span crane consists of two normal 40ft span cranes permanently linked together and equipped with an overhead control cabin.

The whole of the structural steelwork for the new medium and light machine shops was made in the company's works, and a paper on the design of the light shop structure was presented by Mr. Bullen, the consulting engineer, before the Institution of Structural Engineers.

In one corner of the light machine shop an area some 170ft long by 40ft wide has been partitioned off and equipped as a tool room to serve the works. Under the system which has been adopted all cutting tools returned from the machines to the stores are automatically passed into the tool room for reconditioning, and as each job is issued for a machine it is accompanied by a set of the requisite tools. In addition to its specialised class of work, the tool room is also used for producing the precision components for hydraulic control units and other mechanisms not suited to the general production lines in the shops.

A large area at the lower end of the medium machine bay has been set aside for the assembly of plant, and for this purpose a 5-ton semi-Goliath crane has been installed in one corner to supplement the capacity of a 25-ton and a 15-ton overhead crane which serve the full area of the bay. Much of the rail-mounted equipment—such as slag and hot metal ladles, scale cars and special wagons—is assembled in this section and spurs from the main rail system are extended down one side of the shop for this class of work.

The new equipment which has been installed in the extended heavy machine shop has vastly increased the capacity for machining large and heavy components of all kinds. Typical of these machines is the face-plate lathe which was built by the firm to its own requirements and described in our issue of July 29, 1955. This lathe takes 40-ton workpieces, if the centre of gravity is less than 7ft from the face plate, and swings work up to 34ft diameter and 2ft long. Parts of 100 tons up to 24ft diameter by 29ft 6in long or up to 11ft 9in diameter by 50ft long can be handled on the lathe. To this capacity has been added the two heavy machines which can be seen in our illustration of the shop—a large Butler planer and a Berthiez vertical boring machine. The planer is designed to take 100-ton workpieces up to 10ft wide, 8ft high and 35ft long. It has 70ft long bed slides carrying two tables, which can be coupled together for long components



Light machine shop overhead crane installation in which the tracks of 5-ton cranes can be aligned across the width of the shop

New travelling boom welding equipment in heavy structural shop

or used separately, one being loaded whilst the other is being used for machining. The Berthiez borer has an 11ft 10in diameter table on which support brackets can be mounted for carrying work up to 20ft 8in diameter. Its column carries one ram and its arm carries two rams, and the arm can be elevated to admit work up to 11ft high on the table for machining purposes. Normally, the arms of these machines are fitted with right and left-hand slides on which the rams face each other, but this machine has been supplied to the firm's requirements with both

Set of rolls typical of the class of heavy machine construction carried out to special requirements

slides having the rams on the left, or outer side, to suit the particular class of operation required.

A new Asquith No. 6 ram type horizontal boring and milling machine with a 7in diameter spindle is also an important addition to the shop's capacity. This machine is mounted on ways giving a transverse travel of 41ft, and with its 13ft 6in vertical slide traverse the spindle height is adjustable from 2ft 3in to 15ft 9in above the surface of the floor-level bed of work-mounting rails. The work-mounting bed is set along the full 41ft effective width of the machine and extends to a depth of some 40ft across the shop floor. The spindle has a forward travel of 4ft in the ram, and the ram itself can be extended outwards 3ft.

The whole length of this heavy machine shop is served by two 50-ton overhead cranes, 50ft above floor level, by which work can be handled on the machines and delivered to a large assembly area at one end of the building served by a 15-ton semi-Goliath crane. In addition to making components for its own plant in this heavy machine shop the firm undertakes general machining work and the manufacture and assembly of machines to special requirements. Typical of this class of production for other firms is the set of rolls made for Loewy, which can be seen in course of assembly in the photograph we reproduce. Facilities are available in the works for carrying out both low and high-pressure hydraulic testing of pressure vessels after they have been fabricated or machined.

With the completion of the new 80ft wide, 340ft long, high structural bay adjacent to the constructional department, increased facilities are available for erecting the largest and heaviest classes of fabricated plant under cover so that no delays are experienced owing to climatic conditions and full control can be maintained at all stages. The boom welding equipment in the existing high bay used for heavy vessel fabrication has also been redesigned. Under the original layout vessels were mounted on rotator equipment carried on rail bogies which traversed under a stationary column boom. This stationary column boom has been replaced by two rail-mounted column sets, as shown in one of our illustrations, and the work manipulators or rotators are stationed, as required, in front of the rails. With the new practice longitudinal seams are welded by traversing the columns in respect to the work and vessels up to 150ft long can now be welded. The booms can be equipped with heads for open arc, submerged arc, or CO_2 shielded arc welding.

A job of interest in this part of the works when the photograph was taken is the sphere to be seen undergoing radiographic examination by the column in the background. This sphere, one of two, is 10ft inside diameter and is 2¾in thick. Each sphere is of $18C_R$ 8Ni titanium-stabilised stainless steel and constructed in accordance with the ASME code for unfired pressure vessels. On completion the spheres will be tested to a pressure of 2550 lb per square inch. For the internal welding of the plates a welding head was placed inside and slung from a shaft passed through the manholes at the top and bottom of a sphere. The head with an operator's cradle attached was supported through bearings on the shaft, and remained stationary whilst the sphere was rotated round it during the downhand welding operation.

A mobile 400kVp, X-ray set has been acquired for the radiographic examination of vessels in the constructional department. This set can be used in any part of the shops and whilst it is in operation the area is "bordered" by photo-cell equipment so arranged that should an operator inadvertently move into the danger area the high potential to the X-ray set is switched off.

With the introduction of full production at the new South works the whole of Parkfield works has been closed down with the exception of its iron foundry. This foundry will continue to supply all Meehanite and S.G. castings of up to 25 tons in weight, and to date no plans have been made for its transfer to the new site.

Centenary of the Death of Brunel

On Tuesday, September 15, the president and council of the Institution of Civil Engineers attended the unveiling of a memorial plaque at Clifton Suspension Bridge, Bristol, to mark the centenary of the death of Isambard Kingdom Brunel. An address was delivered by the president, Professor A. J. S. Pippard, which is reproduced below. It may be of interest to readers to refer as well to the article "Isambard Kingdom Brunel—A Reappraisal" by Mr. F. Newhouse, published in our last issue.

I SUPPOSE that in the history of every profession certain great figures stand out and have achieved lasting fame. Engineering has been exceptionally fortunate in this respect. Many names would be unanimously accorded a place on such a roll of fame, and it would be disputed by none that Isambard Kingdom Brunel would rank with the greatest of them.

Genius is hard to define, and whatever its significance in the spheres of music, mathematics, pure science or the fine arts, there is no question that in an applied science such as engineering, we can accept Carlyle's dictum that it is, first of all, the transcendent capacity for taking trouble. No one with any knowledge of Brunel will be in any doubt that he possessed this capacity to the full, and when we add to this his skill at mathematics, the fortunate circumstances of his parentage and upbringing, his single-minded devotion to his profession and his complete self-confidence, we may I think safely credit him with the rare quality of genius.

The Royal Albert Bridge, opened in the year of his death, stands as a fitting memorial of his greatness even if it is considered only on its merits as a superb example of the bridge builder's skill. But it is far more than this : it is a symbol of the completion of the great feat of linking Paddington with Truro by rail, that feat to which Brunel devoted and probably sacrificed his life and which constitutes an epic of civil engineering.

The simple inscription on the piers "I. K. Brunel, Engineer, 1859" is peculiarly inspiring. It does not require much imagination to see it as a personal signature to his last great work and one can almost hear him add the *nunc dimittis*.

But if Saltash is a memorial of Brunel, the suspension bridge on which we stand to-day is a monument to him. Completed after his death and departing in some ways from his original design, this bridge as I need scarcely remind this audience, has a strange history. The original chains, the earliest made to Brunel's design, had to be sold and were used on the Saltash Bridge, while the chains which hang here to-day were purchased when the Hungerford Bridge over the Thames was demolished. There is a peculiar irony in this when it is remembered that Brunel in his Journal for 1835, mentions the Clifton Bridge as "my first child, my darling" and in reference to Hungerford says "I have condescended to be engineer to this—but I shan't give myself much trouble about it."

No one with the capacity and passion for original thought combined with that self-reliance which were so marked in Brunel could expect, or even hope, to avoid criticism and so no surprise need be felt that he received it throughout his career in full measure.

The design submitted by him in the first competition for the Clifton Bridge was rejected by Telford on the grounds that 600ft was the limit of safe span for a suspension bridge. Brunel may have found comfort from the fact that all the other competitors suffered the same fate at the hands of the adjudicator who was then invited to prepare a scheme of his own. This design was, fortunately, ultimately rejected and in the second competition which followed with new referees Brunel's bridge again came in for severe criticism on matters relating to detail, design and calculations. Brunel replied to the criticisms so forcefully and successfully that the referees had to recant. He was awarded the competition

and won his first victory over his critics.

When Brunel laid out the Great Western Railway from Paddington to Bristol his beautiful masonry bridge which carries the line over the Thames at Maidenhead came under fire on the ground that the arches were too flat and it was firmly believed, and I am afraid fondly hoped in some quarters, that when the centering was removed the arches would collapse. This did not happen, and once again the critics were confounded.

The Box Tunnel also provided opportunity for adverse comment, this time particularly by geologists, the most severe of whom was Dr. William Buckland of Oxford. He maintained that the unlined portions of the tunnel were dangerous as they would fall owing to the "concussion of the atmosphere and vibration caused by the train." Brunel in the light of his practical experience of the rock was quite unimpressed by the opinion of academic geologists and rightly so ; parts of the tunnel are unlined to this day.

Accepting that Brunel was a genius, it was only to be expected that he would see further and more clearly than his more pedestrian contemporaries. It is true that on a number of occasions he was possibly too far ahead of his times from a strictly practical point of view, but the risks attaching to this aspect of genius are the price of progress. Brunel was ever ready to take these risks, after he had weighed them and formed his own judgment on them, even when by so doing he incurred the odium of his fellows. A notable example of this is to be seen in the design and construction of his three great vessels, the "Great Western," the "Great Britain" and finally the huge "Great Eastern" all embodying new and startling ideas.

In 1830 he was elected to Fellowship of the Royal Society at the early age of twenty-four. On looking up his original proposal form in the library of the society I found that he was sponsored by, among many others, Michael Faraday and that same Dr. William Buckland who so drastically and misguidedly criticised the Box Tunnel a few years later.

His connection with the Institution of Civil Engineers extended over a long period. He was a vice-president for nine years before his death, and would have been president in 1858, but was prevented from serving by ill-health. All subsequent presidents ought to have regretted this since, even after a hundred years, one feels there would be a measure of reflected glory in filling a chair once occupied by Brunel.

The contemporary attitude towards him was in some ways curious. On consulting the obituary notice published in the *Proceedings* of the Institution of Civil Engineers I learned that "his besetting fault was a seeking for novelty when the adoption of a well-known model would have sufficed." Feeling that this remark must be ascribed to an acute attack of engineer's conversatism I consulted the *Proceedings* of the Royal Society expecting this particular characteristic to be commended but only found a repetition of the same obituary notice.

It seems odd that such a criticism as this could be levelled posthumously against a man one of whose greatest virtues in the eyes of many of us to-day was that he so firmly believed and practised the doctrine that every problem should be examined anew from first principles. If this examination led to the conclusion that established practice was wrong he had no more sympathy with established practice than another great railway pioneer had for the hypothetical "coo" on his line.

The Factories Act, 1959

By A BARRISTER-AT-LAW

THE new Factories Act, which has just received the Royal Assent, reflects in its own sombre way the history of industrial tragedy during the last ten years. From the one or two devastating fires, and some of the most serious of the fatal accidents, the lessons which have been learnt are now embodied in clauses in this new Act, in form an amendment of the Acts of 1937 and 1948. In theory, each accident at any factory in the country which is caused by factors common to other factories should add automatically to the law without the intervention of Parliament, for the publicising of one accident should immediately bring home to other employers and safety officers the risks in their own premises. Unfortunately, the lesson is not always publicised sufficiently, or applied fully to other similar circumstances, and the same accidents recur.

There have been, for instance, several serious accidents in recent years from falls into pits of dangerous, poisonous or corrosive substances, and stricter requirements for the safety of persons near those pits are set out early in the Act. Section 2 deals with the adequacy of fencing, which must now be 3ft above the surrounding ground or floor surface at all points round the pit. Planks across such pits must be at least 18in wide and securely fenced.

Sections 3 and 6 concern two other fairly common causes of serious accidents in factories. Section 3, which deals with hoists and lifting machines, makes it obligatory for an inspector who reports a machine to be dangerous to send a copy of his report to the inspector of the district within twenty-eight days. Section 6 deals with the dangers of entering compartments containing dangerous fumes. New requirements are to replace Section 27 of the 1937 Act, and it is now provided that no one shall enter a potentially dangerous chamber without proper means of exit, breathing apparatus, and a person standing by with a lifeline to pull him out. These requirements are waived only when the space has been certified as safe.

Among the more spectacular accidents come the explosions of steam boilers. These boilers may not now be used in factories unless they have been examined in accordance with the Minister's regulations (Section 8).

A very frequent cause of minor accidents is that of slipping down stairs, or even in level passages, upon patches of oil or odd objects which have been casually left lying about. From litigation in the courts it was not easy to tell how far the management were responsible for objects which could fairly be seen by anyone looking where he was treading, especially when the nature of the work necessarily required a certain amount of apparatus, tools or material at hand. Accidents causing quite long periods of incapacity from work were common, however, and the new Act provides that it is the duty of the employer to ensure as far as is reasonably possible that floors, passages and stairs are kept free from obstructions.

Another frequent cause of action in the courts is the "slipped disc," or similar trouble in the back, causing long periods of disability, which arises usually from attempting to lift too heavy a weight. Section 56 of the 1937 Act, which made it an offence for a young person to be required to lift too heavy a load, is now amended to apply to all employees.

When it comes to the risk of fire, it is surprising that in this enlightened age it should need such major tragedies as the fire at the Keighley woollen mill, and the sadly impressive total of eighty-six recent deaths of workers from fire, before it should be made compulsory for factories to provide and maintain adequate means of fighting fire. Yet Section 12 of the new Act represents the first statutory effort at compulsory provision of fire-fighting apparatus. It is strange even now that the Government, in introducing this measure, should have had to urge in support of it an actual number of instances of tragedies, not to speak of the compelling losses of the Jaguar factory, to cover such an obvious and dramatic danger as that of fire. Yet it is a fact that previous factory legislation has concentrated almost exclusively upon the provision of "adequate" means of escape in case of fire, a standard which appears not to have been reached in practice, to judge by actual casualties.

There are, as well, new ancillary provisions for precautions against fire. The Minister may make special regulations for factories or special parts of factories to reduce the risk of fire or to prevent its spreading (a direct echo from the Jaguar fire), and it is compulsory every three months, and whenever an inspector requires it, for the fire warning system to be tested. A little revolutionary in law, perhaps, though logical enough in this context, is the grant of powers of entry for inspection to officers of the fire brigade, when authorised in writing by the inspector. It is always unpleasant to have to exercise compulsory powers of entry and inspection, however worthy the cause in which the power is exercised, but it may be expected that the fire brigade officers will carry out their duties with courtesy and meet with every co-operation. Even in the biggest and best organised factories their recommendations may prove helpful in saving life and property.

The Act also covers a number of minor points arising from the earlier Acts, and also increases penalties for many offences. It is an unfortunate point against Parliamentary legislation that, although the employer is required to look into the future and provide against accidents which are reasonably foreseeable, Parliament usually refuses to attempt the task. Legislation is based upon accidents which have occurred, rather than upon probabilities. The reason is obvious enough : that there are always opponents to the far-seeing measures, who urge the improbability of the accident against which the precaution is urged, on the grounds that the accident has not yet occurred. Were it not for this attitude, factory legislation might well be more comprehensive and logical in its approach.

Besides the prevention of industrial accidents, the Act has two other objects. One of these is to replace the somewhat cumbersome Defence Regulations with a power in the Minister to relax the regulations governing the hours of women and children. The Minister now has a discretion, on application, to allow relaxation if he feels that it is in the public interest.

A third purpose of the Act is to provide a statutory basis for Government research for health, safety and welfare in factories, and for collecting and disseminating information. This is a new line in factory legislation which may well become of more importance in the future.

LITERATURE

Book Reviews

Fundamentals of Advanced Missiles. By R. B. Dow. John Wiley and Sons, Inc., New York. Chapman and Hall, Ltd., 37, Essex Street, London, W.C.2. Price 94s.

THIS book has attempted to set out the basis of missile system design but it has achieved a somewhat mixed success. There is no doubt that such a book is desirable, for many newcomers and specialists appreciate only a small group of the many diverse but interrelated components which are necessary to achieve a complete weapon. Unfortunately, although the author claims that he is aiming at an introduction to the subject, he also states that he is presenting a comprehensive treatment. The two objectives are not easily reconciled and in spite of a volume of more than 560 pages, neither receives an entirely satisfactory coverage.

This is not to say that there is nothing worth while in the book. On the contrary, there is a great deal of valuable fundamental theory and, at various points, a brief section explaining some of the more practical problems associated with missiles. For most readers a good deal more of this latter aspect would help in understanding the need for the basic equations and analysis which are presented so extensively. There are nine chapters, the first three covering flight kinematics and gas dynamics, the fourth a long treatise on probability and statistics, the next four electronic properties and functions of radar and guidance, together with the associated equipment, and a final chapter on guided missile systems. This last might, with some modification, have been used as an introductory chapter, for it is much easier for the student to understand and accept the detail work if he has a clear idea of how it fits into the picture as a whole.

The early chapters cover the ground which is normally treated in text books on physics, aerodynamics and thermodynamics and would have been better presented merely as a series of equations or statements with suitable references. The development of these in the present book has been too brief for full comprehension by those not familiar with the subject and too long for keeping the text within bounds. The copious use of footnotes indicates that the author realises to some extent the shortcomings of the text, but their incorporation in it would make it of unmanageable length. The same comments can be applied to most of the other chapters, although that on probability can be commended both to the non-mathematician and to the missile engineer. Its discussion on reliability and quality control is very helpful. The penultimate chapter on guidance is also useful and gives the non-specialist a readable exposition of the main systems.

The book has been produced with the care that one has come to expect of modern American technological publications and there do not appear to be any serious errors or misprints in it. The diagrams are clear and generally well-illustrative of the text. In spite of the criticism given above, there is much to recommend the book, which is one of the first serious attempts to provide a comprehensive study of missile systems as a whole.

Mechanical Design and Analysis. By R. R. SLAYMAKER. John Wiley and Sons, Inc,. New York. Chapman and Hall, Ltd., 37, Essex Street, London, W.C.2. Price 76s.

IT is admittedly difficult to teach engineering design (the art of engineering) at a university or technical college : at any rate, little has been done, and this is probably a major contributory reason why so much is now manufactured in this country under licence from foreign designs. This book is a very straightforward and effective attempt to teach the art of engineering, " A realistic approach to design with industrial case studies." Coming from a land which supplies us with so many licences to manufacture—though the original idea may have been British—it " gives one furiously to think."

Much has been said about the educational importance of a sound grasp of basic principles. The ability to apply them effectively in practice is equally important, and in training for the professions of architecture, law, medicine, or accountancy, little or no progress could have been made without emphasis on what the author describes as " case study." The words that Dickens put into the mouth of Mr. Wackford Squeers, of Dotheboy's Hall, " W–I–N–D–E–R, spells winder : now go and clean it ! " were spoken in derision, but the principle involved, an intelligent combination of theory with practice, is the necessary basis of any true professional education, and more particularly so in engineering. Basic principles are often studied better and more thoroughly by analysis of particular cases.

The book, described by the author as a two semester undergraduate course in machine design, falls into two parts : the first is a very useful collection of information and data on limit dimensioning, materials and processes, cyclic loads, working stresses, safety factors, &c., which are the engineer's working tools. Part two consists of a wide range of the kind of examples that occur in engineering practice, displayed and analysed, with alternative lines of approach in many cases. Most of these examples are followed by a number of allied problems of a similar nature which are not worked out but are left as exercises to be done either in class or by the student himself.

One cannot do better than quote paragraph 1 of the author's introduction in full : " The prime objective of a mechanical designer is *to create the most effective device for the least expenditure*. His watchword should be *simplicity*, for a simple device is usually the least expensive one. The words " least expensive " include not only the cost of materials and construction, but also engineering (planning) cost. Analysis is a necessary and important part of a designer's duties, but he must know how much to do of it and when to stop. Ultimately he must decide what to make and how to make it. He must issue clear and concise instructions so that his machine can be built with existing facilities and he must be sure that it will operate effectively and safely. The amount of preliminary study then becomes a matter of the designer's judgment."

Most of the twenty-one specific projects analysed contain a mixture of theoretical analysis, experience gained from practice, conventional and newer methods, and accepted—or modernised—workshop practice, and the results of research, the usual mixed basis of engineering design. It is assumed that the student is studying mathematics, strength of materials, solid geometry, drawing, kinematics, metallurgy, solid and fluid dynamics, &c., elsewhere, and the standard needed in such matters seems to be about that of the Higher National Certificate. It seems difficult for these and other reasons to fit the methods of teaching outlined into any familiar course of undergraduate study in this country. This is not so much a criticism of the book as a reflection that all may not be well with our educational approach to the art of engineering.

The author is Professor of Machine Design at Case Institute of Technology, and also consulting engineer to the Cleveland Graphite Bronze Company ; and he has long been actively engaged in both teaching and practice. The teacher of design who is also an active practitioner is well placed, and both activities can benefit. It is, indeed, difficult, bearing in mind other professional training systems, to see how the art of engineering can be effectively taught in any other ways : we seem to be committed to them, although the effect of neglect in these matters is cumulative. With this point of view in mind the book deserves careful study by all teachers of engineering, though it will be of more value to practising designers than to students, except as indicating the wide range of studies and practical experience that go to the making of a competent designer.

Illustrations are many and well chosen, but the book would be better with more line drawings and fewer photographs which " only show what the thing looks like from the outside." Little emphasis is placed on drawing—as such. It is presumably (and quite correctly) assumed that a high degree of competence in these matters is essential, and automatic, for any engineer. The occasional use of unfamiliar American phrasing, such as " the drawing room," does not lower the value of the book for the English user, and it can be thoroughly recommended, particularly to the engineering departments of the new Colleges of Advanced Technology. There is danger here in that these institutions, in following the university schools of engineering, may over-emphasise the importance of the science at the expense of the equally important art.

The Corps of Engineers ; Troops and Equipment. By BLANCHE D. COLL, JEAN E. KEITH and HERBERT H. ROSENTHAL. Office of the Chief of Military History, Department of the Army, Washington, 25, D.C. Price 4 dollars.

THIS 600-page volume is the first of four which will describe the part played by the Corps of Engineers of the U.S. Army in World War II. This volume tells how the Corps organised and planned and prepared for its tasks and in particular how it trained its troops and obtained its equipment.

Though in general easy to read, it is obvious from the length that this volume is primarily of interest to the student of military matters, be he soldier or civilian. No one should have any great difficulty in mastering the liberal use of the capital letter abbreviations so common to-day in all spheres, but the habit of giving individuals their full

name, rank and job and thereafter referring to them by surname only will cause more difficulty though certainly making the text less cumbersome.

Roughly one-quarter of this volume deals with equipment from the point of view of assessment of requirements, placing of orders, difficulties of delivery and the related problems of maintenance and spares supply. These chapters should have a wider interest than those dealing with the various reorganisations of the Corps, the functions of the many different types of units and the vast problem of training the officers, men and units required for global war.

The equipment problem does indeed bring out many points of great interest to the industrialist, the economist and the student of democratic government. There are many points made which can be used to argue in favour of or against a Ministry of Supply, an organisation which the U.S. Forces have to this day successfully resisted. It will be news to many to read of the severe steel shortage in the States during 1942 and the difficulties of obtaining even standard industrial items. Even secondhand equipment was used to meet the needs of the Corps of Engineers with all the associated problems of reliability, overhaul and spares supply.

One is left with the impression that the problems of repair and spares supply did not receive adequate attention, though that this was not due to any lack of awareness on the part of those responsible for these activities the following extract will show: "Except in extreme cases, only one make and model of any one type of power equipment should be procured in future . . . . . The practice of 'splitting' orders for mechanical equipment among various firms should be stopped completely, except when the replacement parts for such equipment are interchangeable, or when vitally urgent delivery dates cannot otherwise be met to any reasonable degree. Manufacturers should be prevented from changing models, using different sub-assemblies, bearings, clutches, carburettors, &c., except under extreme conditions of necessity"; and again: "... the quantity of spare parts placed on the order books was tremendous. It was so large in fact that manufacturers could not believe it represented a real need. The Maintenance Section could understand this scepticism. Under normal peacetime conditions of operation and ready access to dealers' stocks, the Maintenance Section figured a construction machine costing 2500 dollars would require approximately 750 dollars worth of spares for eighteen months maintenance. Under wartime conditions, with no dealers' stocks to fall back upon, 2000 dollars worth of parts were required."

These vital points to any maintenance organisation, standardisation and adequate spares supply, the one stifling the development of equipment, the other reducing the maximum number of complete equipments obtainable on a limited budget, have to this day not been effectively solved, though there are signs that the U.S. Army, with its far greater numerical requirements, may be within sight of an acceptable solution.

The more predominantly military chapters are far from without interest to the civilian with an enquiring mind. It is of value that the authors of this volume are all civilians who have apparently set out to give an unbiased account. They certainly succeed in giving a graphic view of inter-service and inter-arm rivalries. They do not gloss over faults in planning or execution. They show that the Corps of Engineers, used to obtaining the top men from West Point and to meeting its quota of forty-fifty from the top seventy out of classes of over 400, were reluctant to accept more and more units being relegated to a service role and gave constant battle to maintain the importance of their combat role.

This volume is likely to have a wider appeal than those which are to follow and which will deal with military construction in the United States and engineer operations overseas in the European and Pacific areas.

Advanced Structural Analysis. By S. F. BORG and J. R. GENNARO. D. Van Nostrand Company, Ltd., 358, Kensington High Street, London, W.14. Price 56s. 6d. THE first half of this book presents the classical methods of structural analysis. The method of presentation is clear and is based on the normal mathematical approach. A fairly long chapter is devoted to the moment distribution method and attention is drawn to the excellent Portland Cement books giving frame constants for beams of variable inertia. The second half of the book treats of torsion, temperature stresses, shells, plastic design and the application of electronic computers to structural analysis. This is a formidable list to be squeezed into 200 pages but it can be said to give a useful introduction to these subjects. Adequate references are given, with two notable exceptions. The first is that no reference is made to Professor Baker's work in the chapter on plastic design, and the second is the selection of the references for shell design where an isolated British book is chosen as representing European practice in this field. The chapters on torsion and temperature stresses are clear but the chapter on computers is too short to be really helpful.

The book will be of more use to the student than the practising engineer, but the latter should find a sufficient introduction to the various topics discussed to enable him to read intelligently the references given.

Books Received

First Steps in Heat Transfer. By J. Small. Blackie and Son, Ltd., 17, Stanhope Street, Glasgow, C.4. Price 12s. 6d.

Metal Industry Handbook and Directory, 1959. Iliffe and Sons, Ltd., Dorset House, Stamford Street, London, S.E.1. Price 21s.

Water Engineer's Handbook, 1959. The Colliery Guardian Company, Ltd., 30 and 31, Furnival Street, London, E.C.4. Price 20s.

Electricity and Magnetism for Engineering Students. By A. W. Hirst. Blackie and Son, Ltd., 17, Stanhope Street, Glasgow, C.4. Price 40s.

Matrix Calculus. Second Edition. By E. Bodewig. North-Holland Publishing Company, Amsterdam, P.O. Box 103, Holland. Price 65s.

Over the Drawing Board. Second Edition. By R. Forman. Cleaver-Hume Press, Ltd., 31, Wright's Lane, Kensington, London, W.8. Price 15s.

Mechanics. Part 2, Dynamics. Second Edition. By J. L. Meriam. Chapman and Hall, Ltd., 37, Essex Street, Strand, London, W.C.2. Price 40s.

Definitions and Formulæ for Students. By L. S. Powell. Sir Isaac Pitman and Sons, Ltd., Pitman House, Parker Street, London, W.C.2. Price 2s.

Power Plant Theory and Design. Second Edition. By P. J. Potter. The Ronald Press Company, 15, East 26th Street, New York, U.S.A. Price 10.50 dollars.

Radio Circuits. A Step by Step Survey. Fourth Edition. By W. E. Miller. Iliffe and Sons, Ltd., Dorset House, Stamford Street, London, S.E.1. Price 15s.

Fundamental Aspects of Reactor Shielding. By H. Goldstein. Addison-Wesley Publishing Company, Inc., 10-15, Chitty Street, London, W.1. Price 9.50 dollars.

Electronic Engineer's Reference Book. Second Edition. Edited by L. E. C. Hughes. Heywood and Co., Ltd., Carlton House, Great Queen Street, London, W.C.2. Price 84s.

Technical Reports

The Rectangular Plane Pad Bearing. By Bengt Jakobsson and Leif Floberg. Report No. 5 from the Institute of Machine Elements, Chalmers University of Technology, Gothenburg, Sweden. Göteborg: Gumperts Förlag. Price Kr.5.—Three previous reports from the Institute of Machine Elements, Chalmers University of Technology, Gothenburg, have dealt with the lubrication of full and partial journal bearings of infinite and finite width, with or without cavitation zones. The present report treats theoretically the rectangular plane pad bearing of infinite and finite width. Several values of ratio (width/length) and the oil film thickness ratio are used; the viscosity is assumed to be constant. Charts and tables are given for load capacity, load location, oil flow, power loss, temperature rise, and relative power loss. A schedule to be used in pad bearing calculations is given.

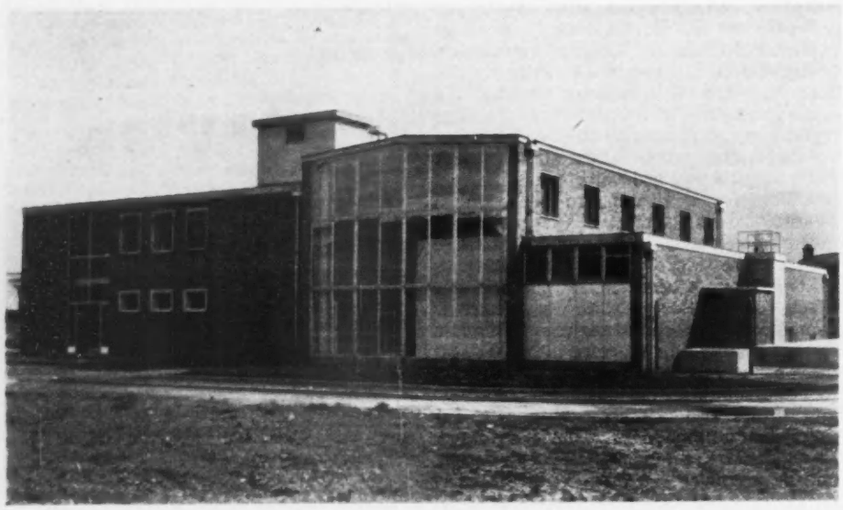
Noise Reduction in an Oil Piping System. By I. S. Pearsall, B.Sc. (Eng.), Ph.D., and J. Kane. MERL Fluids Note No. 72. Mechanical Engineering Research Laboratory, East Kilbride, Glasgow.—Noise can be troublesome in oil piping circuits. Tests have been made of methods of reducing the transmission of noise through pipes over a frequency range of 2 to 20 kc/s. It appears that attenuation can be achieved by introducing materials or gases of greater compressibility than the oil, with as large a common surface as possible. Attenuations of 30 dB to 40 dB over the range of frequencies could be obtained either by lining the silencer with "Dunloprene" in an impermeable envelope or by maintaining a screen of air bubbles across the flow, these effects being not seriously diminished for flows up to 40 gallons per minute through a silencer 10in in diameter. For suppressing selected frequencies, techniques such as passing the oil through small passages in a screen of "Polyzote" were effective.

The Calculation of the Median Sky Wave Field Strength in Tropical Regions. By W. R. Piggott. D.S.I.R. Radio Research Special Report No. 27. H.M. Stationery Office. Price 2s. 6d.—This paper is an attempt to improve the prediction of the sky wave h.f. field strengths in tropical regions with particular attention to the broadcasting systems. Curves are given which can be applied directly to any service operating over ranges up to 4000km and may be used for greater distances in conjunction with the techniques and long-range spatial attenuation curves published in the standard references or using revised data given in an appendix of this report. In summarising the characteristics peculiar to low-altitude propagation, and describing the principles of the prediction system, the report is based on and extends the existing methods, but uses revised values of the basic equations and is modified to take advantage of recent work. The prediction equations are presented in nomogram form.

The Lighting of Factories. By M. J. Keyte and H. L. Gloag. Factory Building Studies No. 2, Department of Scientific and Industrial Research, Building Research Station. H.M. Stationery Office. Price 3s. 6d.—Whether lighting is natural or artificial, there are certain common principles to observe in ensuring that work can be seen clearly and comfortably. These are explained in the opening section of the report, which then proceeds to show how such principles can be applied in practice by fenestration and by the choice and positioning of artificial light sources. Particular importance is attached to good distribution of light, emphasised by illustrations showing how a misguided attempt to direct the maximum proportion of the light from lamps on to the work may defeat its object by introducing glare and excessive contrasts, creating dark shadows which impede the operator. Attention is directed to the importance of providing easy access to lighting fittings for maintenance, cleaning and periodical relamping, without which the full benefit of an installation will not be enjoyed; and suggestions are made for a study of ways of facilitating this work such as movable platforms from which glazing and general works services can be reached as well as lighting fittings. A section on choice of lamps includes a life table of typical light sources and notes on capital and running costs appertaining to filament and discharge lamps. It is noted that in some factories artificial lighting is necessary by day in areas away from windows, and here illuminations of from 50 to 100 lumens per square foot are recommended to avoid such areas appearing excessively gloomy or under-illuminated. Similar levels are likely to be required in premises where lighting is totally artificial in order to overcome a sense of disadvantage as compared with good daylighting conditions. For other situations the levels recommended range from 100 lumens per square foot for small assembly to 7 lumens per square foot in offices used for inquiries and reception, and in waiting rooms.

Irradiated Materials Laboratory

The laboratory illustrated here has been set up for the study of irradiated materials by Metropolitan-Vickers Electrical Company, Ltd., at Wythenshawe, near Manchester. It is equipped with two "caves" and a sequence of "hot" cells with remote handling systems whereby irradiated specimens and components (with an activity up to 10 kilocuries) can be examined and tested.



A NEW laboratory for the examination and testing of irradiated materials has been built and equipped by Metropolitan-Vickers Electrical Company, Ltd., on a site adjoining the company's Wythenshawe transformer factory. It will be used to study the effects of radiation on the properties of materials used in a nuclear reactor. It is equipped for carrying out metallurgical tests on specimens that have been irradiated for known periods. It is also suitable for the examination of components taken from a reactor after specified periods of service; a complete fuel element with an activity of about 10 kilocuries can be handled.

The laboratory is housed in an L-shaped brick and concrete building which is capable of being extended, for example, along the main axis where one end face consists entirely of metal-framed glazed panels. In its present form the floor area is about 8000 square feet. The main "active" laboratory occupies the longer wing of the building shown to the right. It contains two large concrete caves in which large irradiated objects are received, and a train of five interconnected lead-walled cells in which specimens are examined. An annexe on the far end of this wing provides decontamination facilities and has a filter room below floor level to take contaminated water from the cells and caves.

The shorter wing to the left is a two-storey block providing office accommodation, laboratory space for work on non-radioactive materials, a health service laboratory, a ventilation room, changing rooms and laundry, a dark-room and a small workshop.

As indicated above the two concrete caves in the main laboratory (Fig. 1) are designed for the reception and initial handling of large irradiated objects such as test rigs or complete fuel elements. These caves are built of barytes concrete blocks forming walls 3ft thick, the inside dimensions of each cave (Fig. 3) being 8ft by 6ft by 11ft high. Lead sheet of shielding value equivalent to that of the walls is used as jointing material between the blocks. Large doors are provided on the west side of the cells, extending to the full height, and opening into the access area. Each door weighs 25 tons and is mounted on four roller-bearing "skates." The inner side of each door and the walls of the caves are lined with tinned sheet steel, painted with epoxy resin paint, and when each door is closed an airtight seal is formed.

Air is extracted from the caves, through filters fitted in them, by the main air extraction system. This system keeps the air in the caves at a slightly lower pressure than the air in the open laboratory, and ensures that no airborne radioactive dust can escape from them.

Remote control manipulators enable the operations to be carried out inside the caves from a position outside the walls. Television cameras are mounted inside and are connected to monitors outside the cave which are in the view of the operators. Small lead-glass observation windows are also provided, from which the whole of the lower portion of the interior can be seen.

Special ports are fitted to allow radioactive fuel elements to be transferred from the massive lead containers, in which they are transported, to the interior of the caves; these ports are closed by thick lead doors when not in use. Lifting devices, controlled from outside the caves, receive the incoming articles and transport them around the cave. One cave is designed to contain a cutting machine for dissecting fuel elements. This cutting operation is arranged to take place under water to prevent the spreading of radioactive dust, and the machine also removes the "can" from a fuel element, cuts up the "can," and cuts out sections from the fuel element itself. In the other cave, the specimens can be examined visually via the television circuit, and their dimensions measured accurately before dissection.

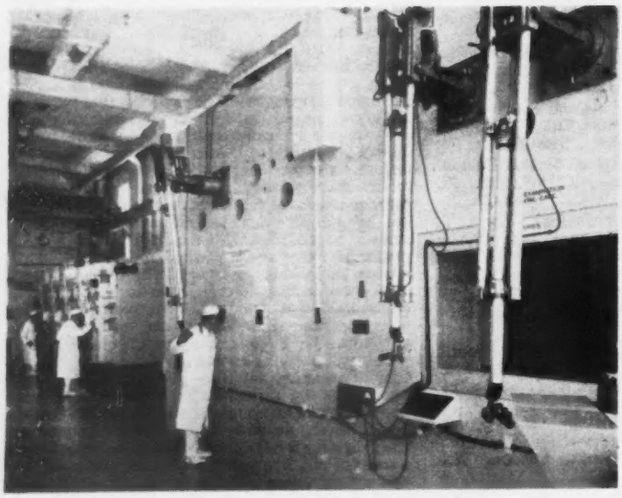


Fig. 1—Experimental "caves" (right) and train of metallurgical testing cells in irradiated materials laboratory

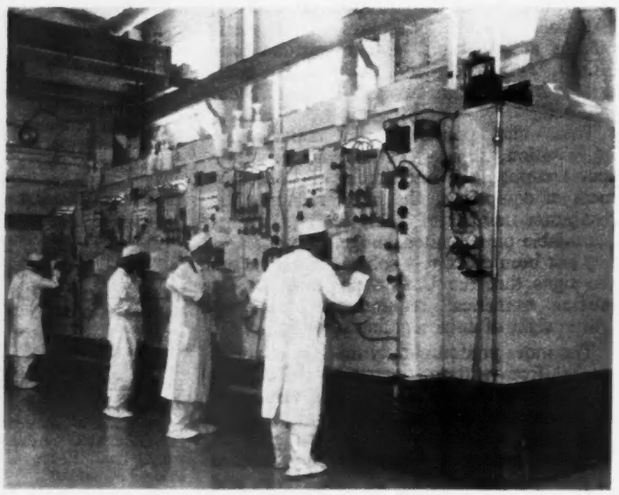


Fig. 2—Line of cells equipped as a metallographic "train"

Mechanical testing can also be done in this cave.

Metallographic Train

When this preliminary examination has been completed it may be necessary to do detailed metallographic examination on selected portions of the fuel element assemblies. For this work, a line of five lead-walled cells has been set up and equipped to provide a complete metallographic train or sequence operated by remote control.

All five cells are in line (Fig. 2), with connecting ports built on a concrete bench and arranged to enable operations to be controlled from both sides of the line. The cell walls are made of 6in thick lead slabs, with the roof in the form of a removable concrete slab, and each cell has an inner container constructed of steel and " Perspex " making it practically airtight. This inner container is maintained at a slightly lower pressure than the laboratory by extracting air from the cell via a filter into the main air extraction system. Lead-glass windows and spherically mounted handling tongs are provided on both faces of each cell, and remote controls for apparatus in the cells are brought through the walls where needed. All these controls are arranged so that they can be disconnected and the inner container lifted out as a whole when necessary for cleaning and decontaminating. Each cell has an entrance port with a sealed door, whereby objects can be transferred between closed containers and the cells without causing any radioactive hazards. The transfer ports between adjacent cells allow objects to be passed from cell to cell as required.

A typical radioactive sample may traverse the line as follows : the sample is assumed to consist of a small section, say $\frac{1}{8}$in thick, of a uranium rod about 1in diameter from a fuel element which has been dissected in the large caves. It is transferred from the caves to the first cell in a small lead coffin which is run up on a stand to the entrance port of the first cell. The port of the coffin and of the cell are opened and a transfer mechanism pushes the sample into the cell where it is deposited on a tray at the end of a movable arm. The ports are closed, the coffin is removed, and the arm moves down so that the sample can be lifted out of the tray by one of the handling tongs. In this cell is an Oertling balance, on which all weighing can be carried out by the addition and removal of riders remotely operated from outside the cell. In this way the specimen is weighed and its density determined. Then the specimen is mounted in cold setting resin by means of an automatic mounting device in this cell.

Next the mounted specimen is put in the transfer tray and sent through the transfer port into the second cell where there are three standard automatic polishing machines. The first is equipped for rough grinding the surface of the specimen, and the second and third machines can be used with interchangeable polythene carborundum laps to polish and lap the specimen to a suitable finish. Changing the lamps and moving the specimen from one machine to another is done by the handling tongs.

The specimen is then transferred to the third cell which is equipped for attack-polishing, electro-polishing and anodising.

At present, the fourth cell is a spare one, but it forms a useful temporary storage space for specimens which may be awaiting attention or which are being kept for future reference.

In the fifth or end cell is a variable-load hardness testing machine, and a Reichert microscope, modified for remote control, on which a full metallographic examination can be carried out. This microscope has all its controls on a control panel outside the cell, and the image formed by the microscope is also brought out through the walls of the cell by an optical system to a camera outside. This optical system is arranged to have two right-angle bends in it to obviate any direct paths for the emergence of radiation from the interior of the cell. Thus, a complete metallurgical examination can be carried out, and a photographic record obtained of the results, on radioactive specimens without any danger to the operators.

Primarily the new laboratory is engaged on work for the A.E.I.-John Thompson Nuclear Energy Company, Ltd., and on work under contract for the U.K. Atomic Energy Authority.

Irradiation examinations planned at present on behalf of the A.E.I.-John Thompson Nuclear Energy Company, Ltd., include certain aspects of the prototype fuel element assembly and sub-components used at Berkeley power station, for which A.E.I.-John Thompson is main contractor to the C.E.G.B. Components of the fuel element temperature measuring circuit and the control rod system are also being studied and an extensive examination of the effects of irradiation on zirconium alloys is being carried out in connection with the support bridges used in reactor fuel element assemblies. Some of the special properties investigated include spring behaviour and other matters of interest from the point of view of mechanical stability of reactor fuel elements.

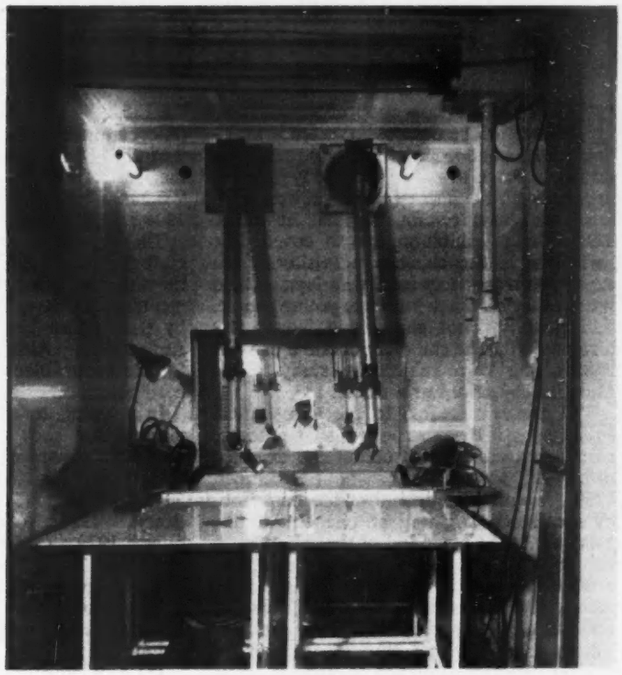


Fig. 3—Remotely controlled manipulators and closed circuit television cameras in the cave equipped for visual examination

Decontamination System

Close to the hot cells and the caves in the main laboratory there is a decontamination room, with a suite of changing rooms for the people who work in this area and who wear protective clothing, as shown in our illustrations. The floor of the decontamination room is surfaced with p.v.c. and falls to a specially constructed sump, which contains filtering equipment. Contaminated washing water drains into this sump and is filtered and pumped to the main effluent-treatment room. A local air filter which can be removed remotely deals with the air which is exhausted from the room into the main ventilation system.

There is a water-spray to enable operators wearing special clothing to be washed down before leaving the area. An observation window is set in the wall so that operations in the room can be observed and controlled by an operator outside it.

Contaminated water from the cells, caves and decontamination room is taken by copper drain pipes to the chamber at the south end of the main laboratory. There it is filtered through batteries of ceramic candle filters in a screened cell, and then passed through an expendable-cartridge ion exchange unit, after which it is pumped into a holding tank. The water filters can be changed remotely, as can an air filter located within the filter cell.

Two holding tanks to take the contaminated water are in the underground chamber referred to, and there are two further tanks holding effluent from sinks and washbasins. A fifth tank is installed for emergency use.

Air Filtration Plant

A ventilation plant room on the first floor of the laboratory and, above it, an air extract duct, can be seen in the heading illustration. The plant room contains a battery of inlet air filters and a blower to force filtered warm air into the building through a system of ducts and grilles. A second system draws air from the " active " parts of the building and exhausts it through a main bank of Poelman absolute filters if there is radioactive contamination. If there is no such contamination, the filters are by-passed. An automatic electromagnetic valve controls the by-pass system and this valve, in turn, is controlled by a Rotheroe and Mitchell monitor, which also gives a continuous record of the air condition. The filter units in the main bank can be removed and replaced remotely, but since air extraction from all volumes containing radioactive matter is done through local filters, the main bank of filters is purely a second line of protection.

Health Physics Service

A health physics service is part of the laboratory. It is operated by the radiation laboratory of the Metropolitan-Vickers Research Department to check the safety of all operations and to keep continuous watch on radioactive contamination levels.

The new laboratory has been designed on the principle of first containing the activity in known channels and then filtering all water and air that has been in contact with active material during operations. Most of the loose activity will be carried away from cells and caves by water flow and removed by

filtration and ion exchange processes. Before release to the outside drainage system the water will be checked for residual activity, using a scintillation counter (specially developed by the research laboratory) sensitive enough to record almost down to the levels considered permissible for drinking water.

Inside the laboratory there are two Rotheroe and Mitchell air monitors for measuring alpha and beta activities down to the very low tolerance levels set for fission products such as strontium 90 and for alpha emitters such as plutonium.

A Philips hand and clothing monitor and the usual Airmec 1021 monitors are in use for checking personal and equipment contamination levels, and in the health physics laboratory counting and analyser equipment is installed for the investigation of particular problems. For personnel monitoring both film badges and pen-type dosimeters are in use, and in addition the usual medical checks are carried out by the company's medical department.

The laboratory building was planned in collaboration with the architects, Messrs. Harry S. Fairhurst and Son.

Science Museum Aeronautical Gallery

THE aim of the collection of aeronautical exhibits at the Science Museum, Exhibition Road, London, in addition to preserving historic relics, is to show present-day practice, in relation to the history of the subject, using the exhibits as three-dimensional illustrations. The style of exhibition has to cover wide variations in the capacity of visitors from experts to reasonably intelligent laymen, and yet must be comprehensible to young people. The specialist is not ignored and, indeed, it is recognised that he can often obtain a broader view of his own subject by studying the Museum collections as a whole.

The gallery allocated to the aeronautical collection is on the third floor of the new centre block, now under construction and expected to be ready for occupation about December, 1960. Visitors will ascend to the third floor by escalators, alighting at one end of the gallery. At the other end of the gallery a tea bar is to be incorporated and an attractive view of the aircraft should be obtained from there. The floor space is to be 225ft long by 80ft wide, an area of 18,000 square feet. This is an increase of 50 per cent over the existing Western Galleries of Imperial Institute, where the aircraft are housed at present. This old gallery is scheduled for demolition, along with Imperial Institute, in 1961, to make way for new buildings for the greatly enlarged aeronautical and scientific research departments of the Imperial College of Science and Technology. A smaller adjoining gallery of 2500 square feet has been allocated for an as yet undeveloped section on astronautics and rocketry.

The roof of the main gallery will be of cantilever construction and will enable a number of aircraft to be suspended from it. The maximum internal height is 30ft and the absence of columns will permit good use of the space provided. The furnishings of the gallery are to be designed and supplied by the Ministry of Works. The major feature is to be a walkway, 9ft above floor level, from which aircraft may be viewed from the side or from above. Windows, down to floor level, extend the full length of the gallery to give an air of spaciousness and the problem of where to place exhibition cases will be solved by incorporating most of them under the walkway.

Full-Size Aircraft

The following aircraft are on exhibition at the present time :—

(1) Wright biplane, 1903 (reproduction) ; (2) Roe triplane, 1909 ; (3) JAP/Harding monoplane, 1910 ; (4) Antoinette monoplane, 1910 ; (5) Fokker " E.1," 1916 ; (6) " S.E.5A," 1917 ; (7) Vickers " Vimy (Alcock and Brown), 1919 ; (8) de Havilland " Moth " (Amy Johnson), 1930 ; (9) Supermarine " S.6B," 1931 ; (10) Gloster " E.28/39," 1941 ; (11) " V.1 " flying bomb, 1944 ; (12) " Canberra " cockpit, 1952.

The last-named is the cockpit of the aircraft that made the first double crossing of the Atlantic in one day and forms a complementary exhibit to No. 7. It was presented by the English Electric Company, Ltd., in April, 1959. Although primarily intended for the centre block display, it has already been placed on exhibition.

In addition to the above machines it is planned to show the following aircraft, which are now in store :—

(1) Cody biplane, 1911 ; (2) " Avro 504K," 1918 ; (3) Westland-Hill " Pterodactyl," 1926 ; (4) Handley Page " Gugnunc," 1929 ; (5) Cierva " C 30A " autogiro, 1935 ; (6) " V.2." rocket, 1944 ; (7) car of " Beta " airship (Farnborough), 1910.

The following are also to be shown, having been specially acquired for the new exhibition :—

(8) Supermarine " Spitfire," 1940 ; (9) Hawker " Hurricane," 1940 ; (10) Messerschmitt " Me 163," 1944 ; (11) Rolls-Royce vertical take-off test rig (" Flying Bedstead "), 1954 (earmarked, but not yet acquired).

Not all the latter eleven machines listed are at present in a condition good enough to be a credit to the manufacturers or the national collection of aeronautics, and it is hoped that assistance will be forthcoming from industry to bring a number to a suitable standard. Promises have been received for a proportion of this work ; but, so far, not enough to bring numbers (5), (6), (7), (9) and (10) to suitable condition.

The lists given above are, however, not quite finalised. The Royal Aeronautical Society has suggested that one or two of the Nash collection may be available for the Science Museum display. The final selection, to be made in consultation with the Society, will be considered from both the historical aspect and the condition of the individual machines.

Model Aircraft

Nearly 200 models illustrate the development of all types of aircraft. It is hoped that many gaps in this comprehensive collection may be filled and that a number of models not to the standard scale or below the accuracy required may be replaced rather than eliminated. Typical of the new displays being devised is one illustrating the rise in maximum speed of fighter aircraft from the Vickers " F.B.5 " to the English Electric " Lightning." Models will be mounted at appropriate points along a curve showing speed performance and it is essential that all models be to the same scale. Several highly detailed sectioned models to a larger scale (1 : 12) are also required (e.g. contemporary airliner, freighter, fighter, helicopter). It is hoped that manufacturers will be willing to lend or present models of their aircraft for the series to a scale of ½in to 1ft (1 : 24). The larger more detailed models are specialised work and it is expected that they will have to be commissioned from specialists in this field.

Aircraft Structure and Equipment

At the present time there are only a few exhibits showing the complexity of the modern aircraft. It is necessary to enlarge this section considerably for the visitor to understand the working of an aircraft and to appreciate the importance of the structural design, and the ancillary equipment side of the industry. One such item is in the instrument section. This was produced a few years ago by the Sperry Gyroscope Company to show an artificial horizon and " gyrosyn " compass under working conditions. It has since been converted into a continuously working exhibit by co-operation between the donors and the Museum workshops.

Assistance with three major technical exhibits has already been provisionally agreed with manufacturers. These are listed below as examples of the type of exhibits required.

Section of " Viscount " Fuselage.—A section of fuselage, 10ft diameter, 4ft to 5ft long, will illustrate fuselage construction. One-half will be furnished with seats, &c., to show an airliner interior (to be contributed by Vickers-Armstrongs (Aircraft), Ltd.).

Undercarriages. — Contemporary undercarriage gear will be represented by a sectioned " Hunter " main leg and the main leg of a " Vulcan." It is also hoped to acquire a working undercarriage leg (to be contributed by Dowty Group, Ltd.).

Wing Section.—A section of a " Twin Pioneer " wing showing construction is to illustrate the mechanical operation of slots and flaps (to be contributed by Scottish Aviation, Ltd.).

Aircraft Engines

The collection of reciprocating aircraft engines is recognised throughout the world as being almost fully comprehensive. There are, however, a few engines which could with advantage be brought to a better condition for exhibition. The continued assistance of industry in regard to new jet engine exhibits is confidently expected.

Aerodynamics Section

Additional space in the centre block has been allocated for educational exhibits in aerodynamics. So far neither finance has been obtained nor final plans agreed for this important development.

Plans for this section include simple smoke and wind tunnels to illustrate the flow of air over wing sections and how an aircraft gains lift ; similar tunnels to illustrate stalling and the effects of slots and flaps ; a water tray analogy to supersonic flight and a simple blowdown supersonic tunnel to illustrate shock wave formation by the schlieren system.

Simple wind and smoke tunnels have been devised by the Museum to illustrate the first two of these points. Development work is, however, required before final manufacture. An elementary supersonic wind tunnel is available commercially and it is hoped that one of these may be acquired.

Depot for Underground Trains at Upminster

A NEW depot for the operation, servicing and maintenance of District Line trains has just been brought into full use by London Transport at Upminster with the completion of a 215ft lifting shop. Upminster depot, which replaces previous somewhat restricted facilities at East Ham, has three reception roads leading to thirteen sidings capable of taking twenty-five trains, a car shed with nine roads, a lifting shop with two roads, and three permanent-way sidings. There are washing machines on two of the reception roads, and all roads in the car shed and lifting shop have pits.

The car shed and lifting shop are steel-framed buildings with continuous patent glazing, by the British Challenge Glazing Company, of the sides and ends, and Universal Twin Twelve asbestos above, as seen in the illustration below. The 11in brick plinth below sill level is in dark, sand-faced brick, and that to the main end walls, the boiler house and stock and separate buildings is in Leicestershire sand-faced brick.

In the car examination shed, 450ft long, eight roads are of full length, capable of taking an eight-car train completely over the pits provided, and the ninth is a short pitted road taking three cars. As the work at Upminster is mainly cleaning and examination, only one of the pitted roads is provided with side pits for detailed inspection of equipment. Pit heating has been installed for the first time at a London Transport depot.

The lifting shop, adjoining the examination shed, is 215ft in length. Although the general arrangement at the depot is single-ended, provision has been made for the lifting shop to be double-ended so that any one of the four cars which can be lifted can be extracted from the shop without interfering with work in progress on the other three cars. The shop has two roads with centre pits running their full length. Each road is long enough to contain two cars with both bogies of each car out and still give space to work on them. The cars are lifted by an overhead 15-ton travelling crane supplied and installed by the Wharton Crane and Hoist Company, Ltd. The support blocks provided for car bodies when clear of the bogies incorporate a pair of wheels to enable them to be moved easily about the shop.

To avoid the provision of overhead trolley leads in the crane bay, the usual method of supplying power to the cars for working them in and out of the shop has been replaced by two pedestal-mounted jumper receptacles, one at each end of the shop between the two roads. Trailer cables are plugged in when power is required.

Trains running into and out of the depot and sidings are directed from a shunting control tower with a thumb-switch panel for operating the power-worked points. The panel is seen in the right-hand illustration, and it will be noticed that the switches are mounted on a diagram of the sidings and are of such a shape that they point out the course of a route which has been set up. Instructions are given to drivers by means of small loudspeakers mounted close to the ground in areas of the yard where trains pull up. The loudspeakers serve also as microphones over which drivers can acknowledge instructions received from the tower without leaving their cabs. When the control tower shunter wishes to speak to a train, he selects the appropriate loudspeaker by pressing a button on the panel. On releasing the button, the loudspeaker is reconnected to the circuit as a microphone for the driver's reply. The installation is operated by two 20W "Mimco" amplifiers, supplied by Marconi's International Marine Company, Ltd., in the control tower relay room. Emergency "stop" signals in the yard can be illuminated from the panel if necessary.

The control tower microphone can also be switched to a Pye 87 mc/s transmitter/receiver installation, housed in the relay room adjacent to the amplifiers, for communication with a shunter - driver who moves trains from siding to siding or into the sheds as required. He is equipped with a fully transistorised "walkie-talkie" set worn on the chest and operating a talk-back loudspeaker. A short trailing lead aerial is used. The equipment, designed and built by London Transport staff, weighs approximately 3 lb in its present steel case. The radio apparatus and batteries account for only 1½ lb. Dimensions of the set are approximately 12in long and 3in square.

A new single-storey substation has been built at the west end of the depot for supplying electrical services and traction in the area. It is equipped at present with two English Electric 750kW pumpless steel tank air-cooled rectifiers. The rectifier transformers, mounted immediately at the rear of the rectifier cubicles, are air cooled by a closed-circuit system with air-to-air heat-exchangers.

Two motor-generator sets for signalling supplies each comprise two single-phase alternators driven by a central three-phase motor, to which they are coupled by vernier connections to allow displacement of the two voltage vectors to any required angle. One generator output is 440V, 15kVA, with leading power factor, while that of the other is 600V, 35kVA, with lagging power factor, and both machines generate at 33⅓ c/s. This frequency should immunise signalling equipment from the effects of 50 c/s traction current on the adjacent electrification of the Eastern Region, British Railways, while the use of two generators will contribute further to this purpose by enabling the local coils of two-element signalling relays to be fed by a source completely independent of that providing the track-circuit feeds. The motor-generator sets were built to London Transport requirements by the Brush Electrical Engineering Company, Ltd.

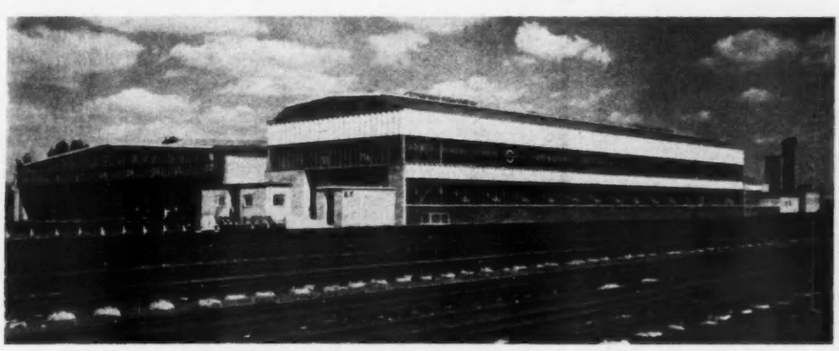
At one end of the substation is the air compressor room, with three "Broomwade" compressors driven by Crompton Parkinson motors with control gear by Allen, West and Co., Ltd.

A new building at the east end of the station includes a signal cabin with a control panel for the two electro-pneumatic interlocking machines which operate the station signalling. The panel and the interlocking relays were provided by the Westinghouse Brake and Signal Company, Ltd. Control is on the route-setting principle, with facilities for preselection of routes, and is effected by illuminated push-buttons which repeat the signal aspects and also show routes which have been preselected and are awaiting establishment when permitted by the interlocking. Signal aspects are also repeated on the illuminated diagram, and points are shown normal or reversed by "N" and "R" indications displayed below the track layout. An Eastern Region railcar service to and from Romford uses a bay platform at the station, and means are provided for the Eastern Region signalmen to request and receive the necessary releases of points for this movement.

Panel in control tower for operating depot points and microphone for loudspeaker or radio communication

Lighting of the depot area at night is provided from two 150ft towers built by Pirelli-General Cable Works, Ltd., one carrying ten and the other twenty-one 1000W floodlights. The main heating installation consists of two Hartley and Sugden "Oilex" boilers, supplying two circuits, one for pit heating and the other for the radiant heating panels. It is found that with the panel system there is a temperature difference of only about 7½ deg. Fah. between floor and roof levels, with much reduced loss of heat through the building roofs.

The main contractor for the civil engineering work at the depot was Holland & Hannen and Cubitts, Ltd., and the main building works contractor was Tersons, Ltd. The depot has been built to the requirements of Mr. A. W. Manser, chief mechanical engineer (railways), London Transport. The civil engineering, signalling, lighting and heating work was planned in the civil engineering and signalling offices of London Transport under Mr. C. E. Dunton, chief civil engineer. The architectural work was under the supervision of Mr. T. R. Bilbow, architect, London Transport. The electrical substation was equipped to the requirements of Mr. T. S. Pick, chief electrical engineer, London Transport.



Lifting shop (foreground) and car examination shed of the new Upminster rolling stock depot of London Transport

Mobile Power Station for Russia

A MOBILE power station mounted on a specially constructed railway wagon has been supplied to Russia by Ruston and Hornsby, Ltd., Lincoln, for providing power on semi-isolated civil construction sites, and in small townships temporarily cut off from electric supplies by severe climatic conditions. The Ruston Mark "TA" gas turbine which drives the alternator is the first British industrial gas turbine to be exported to the U.S.S.R.

The gas turbine drives a 6·6kV, three-phase alternator and has been designed to operate in extreme climatic conditions with air temperatures as low as —40 deg. Cent. Weight of the complete rail wagon assembly (illustrated in Fig. 1), with gas turbine, electrical equipment and auxiliary plant, is about 65 tons, and the unit measures approximately 66ft by 14ft by 10ft. The railway wagon accounts for about half the total weight of the assembly; the chassis for this 30-ton unit was constructed in Belgium and shipped to Lincoln. The bodywork of the wagon and the remaining equipment, apart from the electrical and compressor gear and minor ancillary equipment, were designed and manufactured by Ruston.

When the wagon is stationary and the power plant operating, the sides of the wagon body can be opened upwards to form flaps, thereby facilitating operation and maintenance. Interior fluorescent lighting provides uniform illumination when the body flaps are down or when the plant is operating at night.

The mobile power plant is divided into three main sections, as shown in the general arrangement diagram (Fig. 1). A section at one end of the wagon houses the mechanical auxiliary equipment, which includes the fuel supply system (with 1000-gallon oil fuel tank) and a diesel-driven gas compressor. When the turbine is operating on natural gas, which is piped from an external source as space restrictions preclude the storage of this fuel, this separate compressor is necessary to bring the incoming gas to a suitable working pressure. The two-stage reciprocating compressor is driven by a Ruston "6YDA" air-cooled 110 b.h.p. engine. Installation of an air-cooled diesel for this duty was necessary because of the difficulties of operating water-cooled units in extremely low temperatures.

The centre section (Fig. 3) contains the gas turbine and alternator. The gas turbine weighs about 6 tons—less than one-tenth of the complete station—and occupies just over one-fifth of the total length of the wagon. It may be started from cold in a matter of seconds, and, conversely, can be shut down immediately from full load. This is made possible by the "kinematic" design, which allows free thermal expansion and contraction whilst maintaining alignment during heating or cooling. The Mark "TA" gas turbine is a simple, open-cycle machine with free turbine and was described fully in our March 13, 1953, issue.

Electrical equipment in the third section comprises a switchboard, voltage and current transformers, circuit breakers and a motor-operated reeling drum accommodating 100 yards of armoured flexible three-core cable for carrying the 1000kW, 6·6kV supply. Electrical power take-off via this drum may be obtained from either side of the wagon through outlets in the body walls.

All the electrical equipment, the alternator with exciter and pilot exciter and control gear were supplied by Crompton Parkinson, Ltd. The alternator has an output of 1250kVA, 0·8 p.f., 6600V, three-phase, 50 c/s, at 1500 r.p.m. It is a filter-ventilated machine, having aerofoil pattern fans at each end of the rotor, which draw in air through two Vokes filters mounted in the end covers, so that it circulates through the windings and is exhausted through an opening at the top of the stator frame. The Vokes air filter for the main exciter is mounted in the bedplate underneath the commutator endshield. The pilot exciter is totally enclosed. The whole

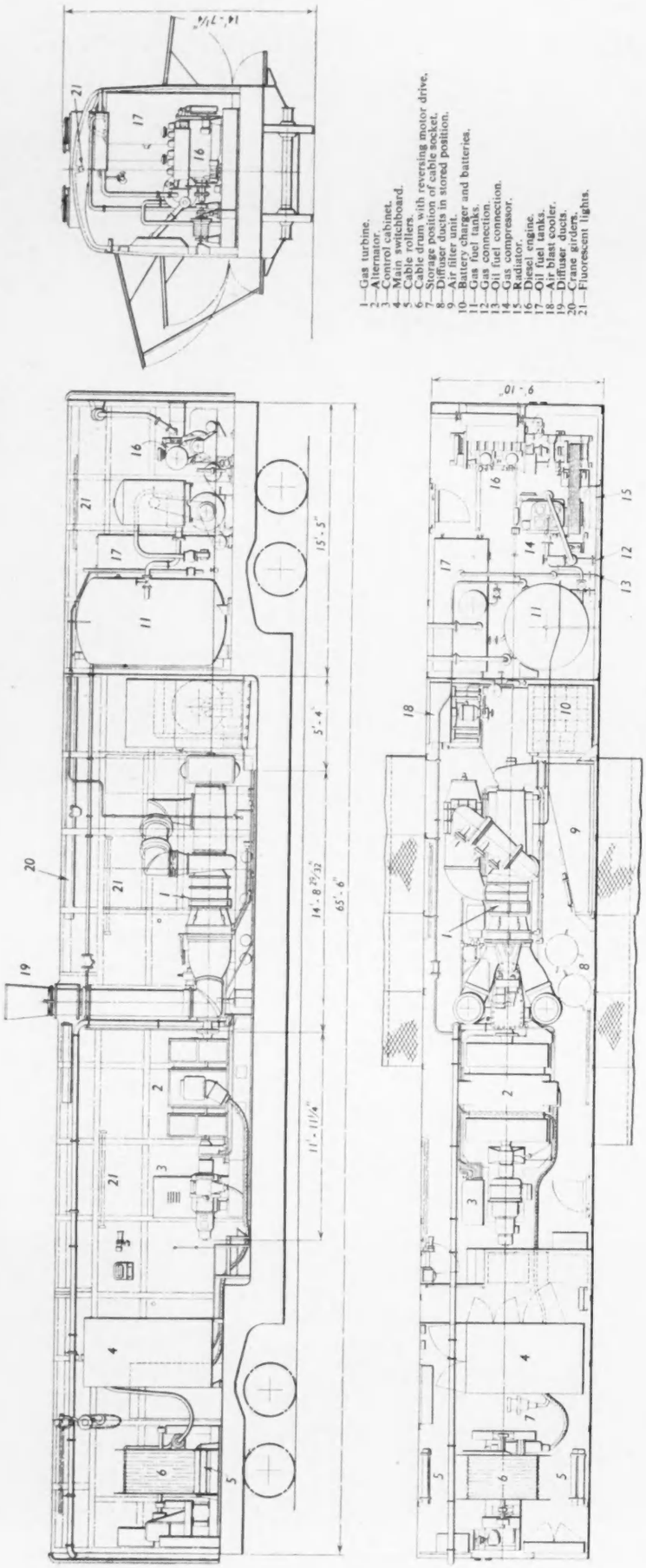


Fig. 1—Vehicle dimensions and layout of equipment

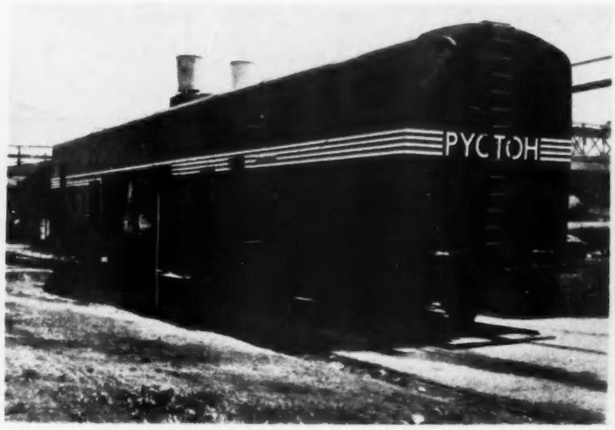


Fig. 2—Railway vehicle housing gas turbine generating plant. The roof diffuser ducts are stowed internally during transit

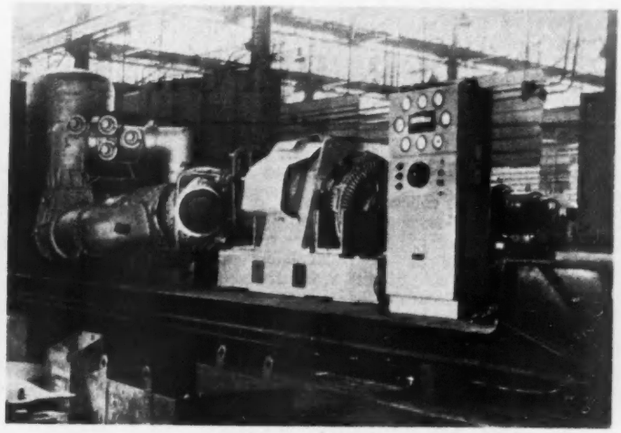


Fig. 3—Gas turbine, alternator and electrical control panel in centre section

equipment is mounted on a substantial steel bedplate which is bolted and dowelled to the bedplate carrying the turbine and gearbox.

The control gear is housed in two steel cubicles carried on anti-vibration mountings and is designed for single and parallel operation of generators. Two voltmeters, a synchroscope and frequency meter are mounted on a steel panel immediately above the neutral earthing switch.

Protection comprises a P.B.O. overcurrent relay and a separate relay to give restricted earth fault protection. Field suppression equipment is mounted inside the exciter cubicle, which also houses a 7½kVA transformer providing power for the auxiliaries. Because this transformer is required to be energised whenever the machine is running, irrespective of whether the main circuit breaker is open or closed, it is fed directly from the incoming terminals and is protected by h.r.c. fuses and included in the zone of restricted earth fault protection. The Brown Boveri "AB2/1" automatic voltage regulator is capable of maintaining voltage within ± 0·75 per cent.

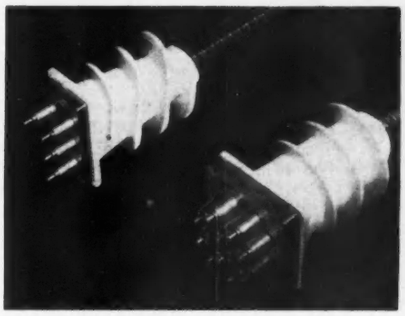
Remote Control of Television Camera

A REMOTELY CONTROLLED vidicon television camera developed by the Engineering Division of the British Broadcasting Corporation has been taken over for experimental trial by the B.B.C. Television Service. The camera is located in the All Souls television interview studio near Broadcasting House, but all its functions can be controlled from the news studio at Alexandra Palace, about 6 miles away. After switching on from Alexandra Palace, the camera is ready to operate within 1 minute. The tripod carries a special head in which the panning and tilting movements are operated by servo motors. Additional servo motors, mounted on a plate fitted to the camera body, are arranged to drive the focus, iris and zoom controls. Operation of the motors and their associated servo amplifiers is controlled from a console at Alexandra Palace or alternatively by the interviewer.

Apart from the console, all the control equipment is at All Souls and is combined in a metal cabinet some 22in square and about 5ft high. In addition to the power supply equipment, this cabinet houses the transistorised servo amplifiers, control relays and four additional sets of potentiometers for controlling the camera functions when under local control. For local control a set of four push-buttons is mounted in a small box at the end of a trailing lead which, in conjunction with change-over controls, allows the camera to be operated locally, for example by an interviewer, to any one of four preset shots. The four shots are preset by controls in the control cabinet which are able to provide an almost unlimited range of camera angles. The whole equipment is mains-operated and can derive its power from any convenient power point. The a.c. servo-motors are driven from a 50V transformer and the transistors are supplied through a 24V metal rectifier.

Anchorage Devices and Stranded Wire Cable for Prestressed Concrete

A NEW range of anchorage equipment for both pre-tensioned and post-tensioned construction in prestressed concrete has been developed by Cable Covers, Ltd., St. Stephens House, Westminster, S.W.1. It includes a system using

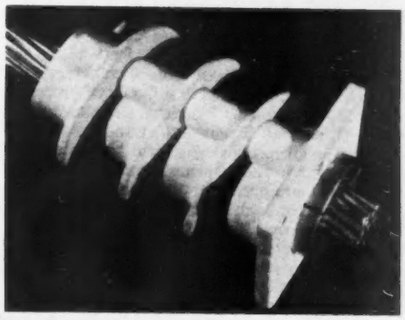


On the left is an eight-wire and on the right a twelve-wire anchorage showing the casting, bearing plate, grips and grout entry hole and cable sheathing

spiral strands of wire, up to 1⅛in in diameter. The use of stranded cables has, until recently, been restricted to the U.S.A.

The first illustration shows newly-developed anchorages for eight- and twelve-wire post-tensioned cables respectively (i.e. conventional cables of 0·276in diameter wires). The dual aims of the design were to distribute the anchorage load and to achieve good compaction of the concrete around the anchorage. This has been achieved by using a casting of "Meehanite" type GE, with a deep spiral formed round its body, as depicted. The casting for the eight-wire anchorage is narrow and deep, so that it can be fitted into narrow beam sections. The dimensions of the two bearing plates are respectively 4¼in by 2¾in and 4½in by 5in. An alternative bearing plate has tapered holes, into which wedges are inserted to grip the wires, and the grips are then dispensed with.

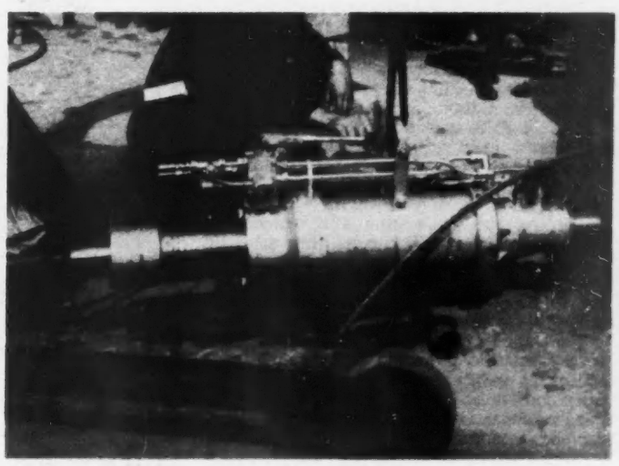
The second illustration shows a casting designed for use with a stranded cable 1⅛in in diameter. Note that in this case there is no



Anchorage for 1⅛in diameter strand, showing wedges in position and grout entry hole

bearing plate, and wedges are inserted directly into the anchorage casting. In this case the casting is of spheroidal graphite iron. The initial prestress for one of these strands is 60 tons, and the minimum ultimate load 80 tons, there being nineteen wires in the strand. The anchorage casting is 7in long, and its end dimensions, where it abuts on to the shuttering, are only 4½in square.

A power-operated jack has been developed for use with the strands. It is shown in use in the third illustration. An 80-ton load can be applied with an extension of 15in and there is a subsidiary ram at the front to lock the wedges. This type of equipment is used with a load cell, since it is considered that extension is not such an accurate guide to load as with the normal wire systems.



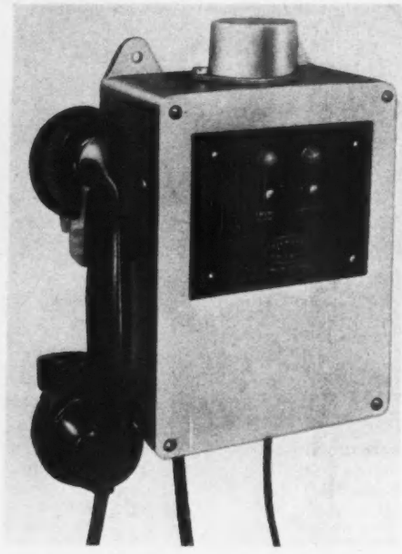
Power-operated jack for large diameter strands in operation, showing standard anchorage and load cell in position

SHORTER REPORTS

Bromley Technical College

A NEW technical college at Bromley of the Kent Education Committee received its first pupils on September 14. The college replaces the technical institutes at Beckenham and Bromley and serves an area with a population of 350,000, covering Bromley, Beckenham, Penge, Chislehurst, Selhurst and Orpington. It is proposed to build an art college on the same site, when the combined capacity would be around 1500 day and 4000 evening students. The present college has departments of engineering and science, commerce, general studies, and domestic science, and also provides specialised week-end courses in collaboration with the teaching hospitals for medical laboratory technicians, who attend from many parts of the country. The buildings comprise a main four-storey teaching block with covered way connections to a workshop block, canteen and an assembly hall with a seating capacity of 750. The architects were Messrs. Pite, Son and Fairweather, in collaboration with Mr. E. T. Ashley Smith, F.R.I.B.A., County Architect, Kent County Council. The general contractor was Gee, Walker and Slater, Ltd., London.

In the engineering department there are two drawing-offices and a print room, a mechanics laboratory equipped for tension and torsion testing and for hydraulics studies, and an electrical laboratory. In the latter the benches are wired so that students can select supplies of 200V, three-phase, or 115V, single-phase, a.c., 24V d.c. from an accumulator and charger installation, or 200V d.c. from a mercury-arc rectifier. Telecommunications studies in line and radio techniques have been extended to a higher level than previously and students are taken from the Post Office and from firms in the industry. Courses are also run for radio amateurs who can build and test their own apparatus under supervision. The college holds a transmitting licence. A workshop for training in electrical installation has cubicles with different types of wall construction for practice in domestic wiring methods. The heat engine laboratory is equipped with an oil-fired boiler and condenser, a B.M.C. 1500 engine coupled to a hydraulic dynamometer, and a single-cylinder compression-ignition engine. Machine shop engineering facilities include vertical and horizontal milling machines, radial drilling machines, shaping, grinding and turning machines, and a forge area. Students of motor vehicle engineering are trained in a special workshop with an inspection pit and two chassis for mechanical and electrical instruction.



Main station intercommunication amplifier, with two-way selector panel

Marine Intercommunication Equipment

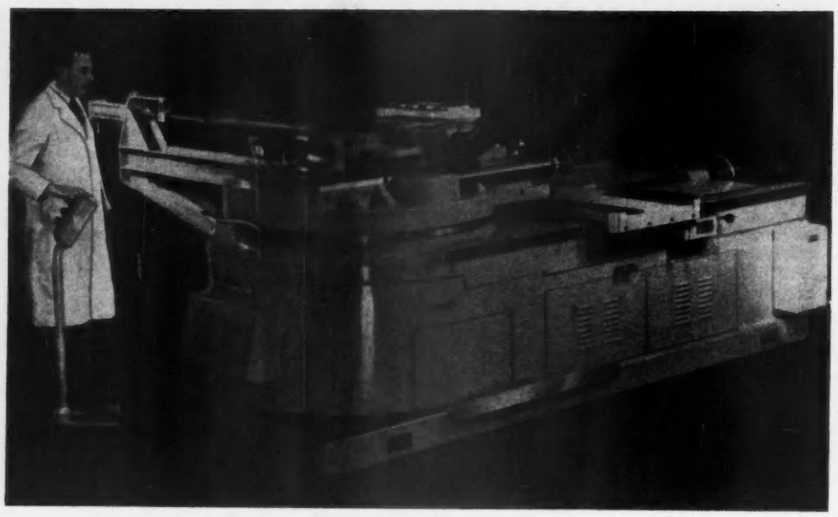
A RANGE of intercommunication equipment for ships developed by the marine department of Siemens Edison Swan, Ltd., Woolwich, London, S.E.18, uses transistor amplifiers and provides a main station (as illustrated) in a space of 9½in by 6¾in by 6in, with the means for selecting two outstations. The corresponding four-way unit measures 9½in by 9½in by 6in. Power may be taken from 12V batteries or from ship's 24V or 36V circuits when these are available. A 24V system requires only 250mA when speech is not taking place, most of this current being used for lamps, and when transmitting the consumption rises to 2A maximum.

The amplifier characteristics concentrate most of the acoustic power in the high-frequency end of the spectrum for good audibility against extraneous noise. Small 50mW amplifiers are fitted at outstations for return speech and these can be equipped either with close-speaking microphones which emphasise speech rather than noise frequencies in situations with a high ambient noise level, or with distant-speaking microphones which in quiet background conditions enable conversations to be carried on without approaching the instrument closely. Loud hailers can be operated from the main station amplifier for distant one-way communication. Two-way outstations may be equipped with either horn or flat re-entrant loudspeakers.

Tube Bending Machine

WE illustrate below a power-operated mandrel tube bender designed by Hilmor, Ltd., Caxton Way, Stevenage, for the production of uniformly accurate full bore bends with cold and unfilled tubes on standard or short radii. The maximum capacity of the machine is 6in bore heavy gauge mild or stainless steel tube and 8in bore non-ferrous tube.

The machine is driven from a 15 h.p. motor coupled directly to a four-speed gearbox, coupled in turn to a single reduction gear transmitting power via a 40in diameter main bearing journal and final drive spur gear to the bending former. A new design of bending head and clamping mechanism has the tube grip clamp and the pressure die housing, which transmit the whole of the bending effort, mounted directly on to the body of the machine. The machine is fitted with a hydraulic mandrel extractor of sufficient stroke to permit the use of articulated mandrels and with an adjustable bracket to carry wiper dies. The machine can be arranged to bend square, rectangular, oval and other forms of non-round tube, finned tube, angles, bar, extrusions and open sections, &c., on the machine.



Bending machine for heavy gauge mild steel tubes up to 6in bore

Computers for Airline Bookings

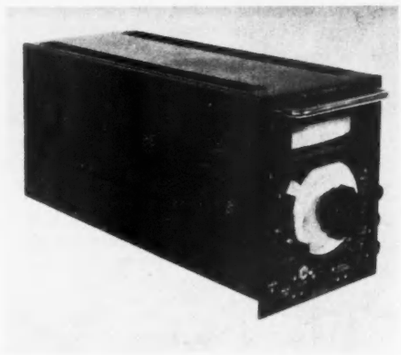
FOR use in the seat reservation system referred to in our March 20 issue, Trans-Canada Air Lines has ordered a fully transistorised computer system from Ferranti-Packard Electric, Ltd., Toronto, the wholly owned Canadian subsidiary of Ferranti, Ltd., Hollinwood, Lancs. The computers will work in conjunction with the "Transactors" to be installed at T.C.A. offices across Canada as described in the above issue. They will be located in Toronto and will comprise two identical machines, both capable of using a common set of magnetic tape and input/output equipment and employing solid state transistor circuitry throughout. The scheme is intended for continuous on-line working and while one computer can be handling reservations the other can be dealing with statistical work.

The computer memory will contain all flight information necessary for the operation of the reservation system, including the number of seats available on all flights. As queries arrive at the computer from any one of about 300 "Transactors," the computer memory will be scanned for the reply. If seats are available the computer will send the information back to the "Transactor" in the form of a punch in a specific place on the card. It will also deduct the seats from its inventory for that flight and will then be ready to handle the next query. Depending on conditions, other replies can be "flight cancelled," "no space," or, if the query card has been marked incorrectly, "error." If a "no space" answer is given, the computer will suggest alternative flights on which space is available. At present Trans-Canada Air Lines handles 3,500,000 transactions in flying 250,000 passengers per month. The Ferranti-Packard electronic system will, it is claimed, reduce the number of necessary human transactions by 60 per cent. In addition, speed of operation will permit reservation inquiries to be handled in approximately two seconds, regardless of the geographical location of the reservation source.

Fault Detector for Grid Lines

AN electronic fault detector has been developed by Ferranti, Ltd., Edinburgh, in co-operation with the North of Scotland Hydro-Electric Board, to facilitate rapid location of faults occurring on 132kV grid lines. Development of the detector was initiated by the Board, many of whose 132kV lines lie across difficult and mountainous terrain, which in winter, particularly, is difficult to traverse. Faults may be latent, such as impaired ground clearance of a conductor, which will not cause flashover at normal voltages; or sustained, as produced by a broken conductor or a badly damaged insulator string. A transient type of fault occurs when lines clash during a high wind, or lightning strikes the line. The board has one type of fault which commonly occurs during the winter, namely, ice accretion on the lines. This begins as a latent fault, since the conductors merely sag, but develops into a sustained fault when the conductors sag sufficiently to touch the ground.

The type of fault locator chosen by Ferranti, Ltd., to deal with these problems was the so-called radar type locator, which works on the



Detector for locating overhead line faults

principle of pulse reflection caused by any local variation in line characteristic impedance. The locator illustrated is a d.c. instrument which is connected directly to the line and cannot therefore be used when the line is "live." In using the locator, the operator adjusts the range dial until a marker stop on the c.r.t. trace coincides with a fault echo, when the range in miles can be read directly off the dial. The instrument is then set to an expanded trace condition in which the trace represents a distance of 10 miles with the range already found at its centre. If the gain is now turned up, echoes from individual towers can be recognised, those from tension towers being identified by their much greater amplitude compared with those from standard towers. Thus an operator with a knowledge of the line can locate the fault to within a span or two by counting tower echoes from a distinctive reference such as a tension tower. With this procedure the towers themselves are used as a calibration scale, but the actual range scale is held to an accuracy of 2 per cent of the total range covered, which in the instrument illustrated is 120 miles. We are informed that it is probable that this locator is capable of covering a range of up to 200 miles of line without major modifications other than appropriate adjustment of the c.r.t. timebase.

The present form of locator is regarded as a preliminary step since it is restricted in the type of fault that it can detect. Further development is proceeding on an a.c. locator, which can be coupled to a "live" line, usually through the capacitor of the carrier control system. This work is being done in co-operation with both the South of Scotland Electricity Board and the North of Scotland Hydro-Electric Board with a view to covering fault conditions on both 132kV and 275kV lines. The technique to be used for the detection of transient faults involves leaving the equipment normally in a standby condition and switching to the operating state in the few milliseconds between the detection of a fault by the normal line protection equipment, and its clearance by the circuit breaker.

Xerographic Printer for Computers

A "XERONIC" output printer to operate at 3000 lines a minute has been ordered from the Electronics Department of Rank Precision Industries, Ltd., 37–41, Mortimer Street, London, W.1, by Ferranti, Ltd. This machine will be delivered in November, 1960, and will therefore be operational only two years after the laboratory prototype was first shown in public at the 1958 Computer Exhibition at Olympia. The printer, to be used with one of the Ferranti computing systems, will print up to 5000 characters a second and will simultaneously print its own forms to contain the information. The printing spread of 24in allows two copies of 12in width or four copies of 6in width of the print-out to be supplied side by side. Paper output speed is 40ft a minute. Four different forms will be printed, the correct one being selected electronically by signals from the computer.

Computer signals are written by an electron beam on a cathode-ray tube screen and this visual image is copied by automatic xerography on to paper at 40ft a minute. The xerographic machine used as part of the "Xeronic" is the "Rank-XeroX Copyflo" continuous printer, which reproduces the information supplied to it on plain, unsensitised paper.

Armourless Submarine Telephone Cable

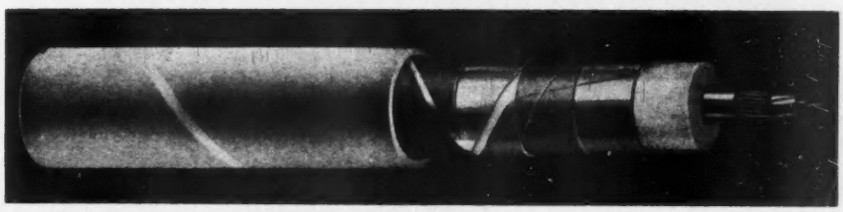
WE illustrate a cut-away specimen showing the make-up of an "armourless" lightweight coaxial cable for the new submarine telephone link between the United Kingdom and Canada. This cable (1635 nautical miles, costing £2,300,000) will be made to the order of Cable and Wireless, Ltd., by Submarine Cables, Ltd., which is owned jointly by Siemens Edison Swan, Ltd., and the Telegraph Construction and Maintenance Company, Ltd., Theobalds Road, London, W.C.1. It will be recalled that Submarine Cables, Ltd., received an order in September last for the 400 nautical mile extension from Newfoundland up the St. Lawrence to the Province of Quebec which will cost £900,000 and last March they were awarded the contract for 550 nautical miles of armoured cable (costing £750,000) for the shore-ends of the main crossing. This company, therefore, will be responsible for the manufacture of the whole of the submarine cable required for the project.

The total contract, worth nearly £4,000,000 in all will, except the St. Lawrence extension which will be owned by the Canadian Overseas Telecommunication Corporation (C.O.T.C.), be jointly financed and owned by Cable and Wireless, Ltd., and the C.O.T.C. and is the first part of the Commonwealth round-the-world telephone cable scheme which was agreed in principle at the Commonwealth Trade and Economics Conference in Montreal in September last.

A single cable to carry speech in both directions will provide sixty telephone circuits, compared with thirty-six channels of the existing "twin" Atlantic telephone cables (one for each of the two directions of transmission), and will contain submerged repeaters (speech amplifiers) for two-way operation.

The armourless cable will be of unorthodox design. It will be a special lightweight non-twisting coaxial cable designed by the British Post Office and developed by Submarine Cables, Ltd., at Ocean Works, Erith, Kent. Instead of the conventional outer armouring its mechanical strength is provided by a central stranded steel wire. This is enclosed in a copper tube to provide the central conductor, and insulated with polythene to a diameter of approximately 1in. Aluminium tapes (outer conductor) together with a polythene binder tape and one aluminium screening tape with a polythene interleaving tape are applied, and the whole given a lapping of anti-corrosion tape and an outer covering of polythene to an overall diameter of about 1¼in.

Trials of this new type of cable were successfully carried out in February, 1958, by H.M.T.S. "Monarch" off Lisbon. The cable can be handled much more easily than armoured cable and this facilitates the laying of the repeaters. The cable for the new contract, which is due for completion in 1961, will be made at the manufacturer's Greenwich factory, where new machinery to manufacture lightweight cable is being installed.



Cut-away specimen of the new lightweight (armourless) coaxial cable ordered for the United Kingdom–Canada submarine telephone cable system to be completed in 1961

Electronic Control of Railway Signalling

PLANS announced by British Railways, Eastern Region, for a new station to serve Harlow New Town, Essex, include remote control of the signalling there from the present Harlow station (to be renamed "Harlow Mill"), by an electronic system. This will make it possible to site the signalbox at a point where direct observation of shunting and goods train movements is required, and, at the same time, have full control and supervisory facilities for a larger station with a four-track layout some 1¾ miles away. The electronic system enables this control to be exercised over a single pair of conductors. Reconstruction and resignalling in the Harlow area is in connection with electrification from Liverpool Street to Bishops Stortford.

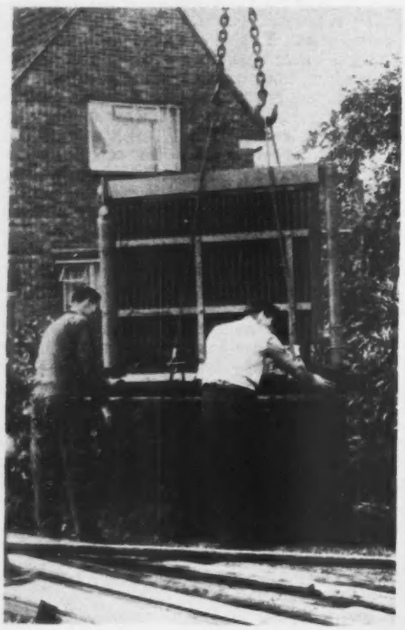
On the London Midland Region electronic remote control was introduced during the resignalling of the Styal loop line in connection with the Manchester–Crewe electrification in July, 1958, and was again adopted for certain functions controlled from the new power signalbox opened at Sandbach on June 8 this year. The area controlled from Sandbach extends over 12 route-miles and includes four self-contained relay interlockings, each of which receives, controls and returns indications over a two-wire circuit by electronic means. The Southern Region has, since June 15 last, controlled the 7-mile branch from Sittingbourne to Sheerness-on-Sea by an electronic installation which links the four relay interlockings at halts and stations on the branch with Sittingbourne signalbox by means of two two-wire circuits. Electronic systems save cabling compared with direct working over individual circuits for every function, and save time compared with conventional remote control methods using trains of coded impulses to identify the locations to which a particular command is being sent, and to select the required apparatus there, when several such locations are connected for economy to a single circuit. It is usually a characteristic of electronic remote control that several commands may be initiated simultaneously, and will be transmitted in sequence within two or three seconds. In conventional coded impulse working, using d.c. or voice-frequency pulses, a command must be sent and its confirmatory indication received before the system will accept another. At the same time, the codes are relatively lengthy

because of the identification information they must contain in addition to the command itself. Electronic systems tend to depend on the principle of sending commands to a particular piece of apparatus at a definite point in a continuously repeated transmitting cycle which embraces all controlled apparatus on one circuit.

Buried Distribution Transformers

A NEW development in the application of buried transformers is announced by Hackbridge and Hewittic Electric Company, Ltd., Walton-on-Thames, Surrey. As illustrated here, the buried transformer is fitted with a cooler which will project above the ground. The picture shows the first of these new equipments at the Edgware, Hendon, district of the Eastern Electricity Board. The transformer itself is a standard oil-immersed core and coil assembly of 500kVA capacity, and has a voltage ratio of 11,000/433V. Tappings are provided at plus and minus 2½ and 5 per cent to a link board, access to which is gained through a handhole in the lid.

The equipment simply consists of the transformer assembly in its tank fitted with horizontal incoming and outgoing cable boxes, and a cooling radiator, including built-in conservator, enclosed in a sheet steel case mounted immediately above.



500kVA buried Hackbridge transformer being lowered into position in Edgware, Hendon district of Eastern Electricity Board

The transformer is buried directly in the ground on a concrete raft, whilst the radiator is mounted on a frame located on the transformer tank so that the bottom of the case is at ground level. The outlet pipe from the radiator incorporates a standpipe to enable the oil to be circulated or the tank emptied. The tank is made from heavy gauge steel and all structural parts buried are protected by an application of flame-sprayed zinc covered by a coating of bitumen. The radiator is a sectional cooler of normal design, the case for which is arranged with cooling louvres on both sides. A lockable inspection door is included to provide access to the oil level gauge and thermometer on the conservator cover.

The introduction of this transformer offers prospects in congested areas where substation siting is difficult.

Units of smaller or larger capacity are available. The height of the radiator is constant (4ft 6in), but the length is adjusted according to the rating. If desired, the transformer can be arranged in a shallow brick-lined cavity with the transformer buried up to its neck so that cable boxes and adjusting tappings can be conveniently reached. Alternatively, the radiator can be mounted separately and offset from the transformer within certain limits.

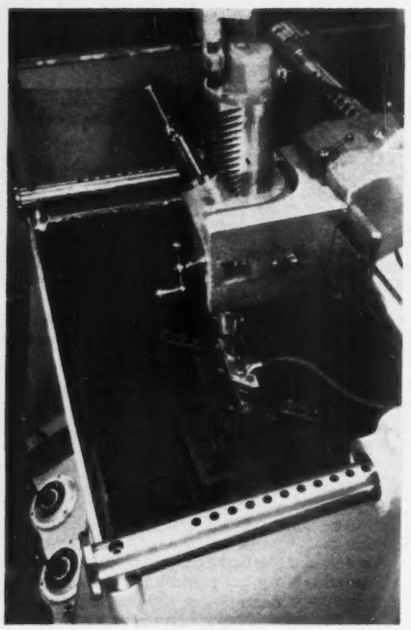
Large-Capacity Spark Erosion Machine

A SPARK erosion equipment, designed for the semi-automatic production and servicing of dies up to a maximum size of 28in by 16in by 15in deep, is now made by Wickman, Ltd., Tile Hill, Coventry. In this machine the inherent self-feeding characteristics of the spark machining process have been employed to produce a machine which, once set up, will continue erosion throughout any die-sinking operation completely unattended. The equipment comprises three

Components of spark erosion equipment arranged in line

units : the machine tool, the generator, and a dielectric fluid circulator. These units can be disposed according to a shop layout ; they are of uniform width and suitable for in-line arrangement, as shown on the accompanying illustration.

The main body of the machine is a light alloy casting, the upper part forming the work tank



Work tank and tool head

within which is mounted a 32in by 20in worktable. Round rails mounted transversely on the work tank support a slidably mounted cross rail which carries the servo head unit. This cross rail incorporates a worm and segment arrangement by which the servo head unit can be pivoted up to the horizontal position. This enables the servo head to be quickly moved to its furthermost backward position to clear completely the work tank area. Unimpeded access to the work tank is then available, enabling heavy die blocks to be loaded and unloaded by overhead lifting facilities.

The transverse and longitudinal travel of the servo head enables it to cover an area 28in by 16in. The transverse cross rail carriage and the servo head can be precisely located in 1in increments ; and a compound slide fitted to the servo head provides means of fine adjustment on both rectangular co-ordinates in increments of 0·001in.

With the exception of a cartridge fused main isolating switch mounted in the rear of the electrical unit and the water stop cock, all the operating controls are effected from a sloping panel on the front of the machine. The work tank has a float switch controlling the generator and servo-control system. This switch ensures that cutting power cannot be delivered to the electrode until the workpiece is properly immersed in dielectric fluid and its fitting removes the risk of fire or danger to the operator from electric shock.

Once setting has been completed the operation of the equipment becomes virtually automatic, and it requires thereafter merely the actuation of the work tank filling cock to start machining, which continues until the depth of impression has been reached and the trip switch shuts off cutting power.

The worktable in the work tank can be lifted vertically if required, and spare worktables can be supplied to enable workpieces to be set up independently. The table is not clamped down, but is held by its own weight.

The servo-controlled tool head is in the form of a self-contained cartridge element and it can be adjusted manually over a length of 6in in a vertical direction to provide for differing thicknesses of workpiece. The head also has a 3in automatic quill stroke driven by reduction gearing from a servo-controlled in-built electric motor, and it is capable of operating a maximum weight of electrode tool of 20 lb. The head is fitted with a graduated scale with which a cursor carried by the moving quill co-acts, and also a dial indicator, so that both coarse and fine travel of the quill may be noted. An adjustable trip switch provided may be set in conjunction with the dial indicator, to shut off the cutting power at an accurate end point of the machining operation. A short taper at the lower end of the servo-actuated quill enables the direct mounting of an electrode carrier or a small chuck.

The electrical equipment is housed in a sheet metal cabinet. The spark generator gives three cutting ranges, which are selected by a lever switch, and alternative generators of 13kW and 4·5kW maximum power rating are offered. In the first range, with a 13kW generator with a controlled frequency of 600 c/s, the maximum metal removal rate is 1000 cubic millimetres per minute, and the loading 12kW. In the second range, with the same frequency, the maximum metal removal rate is 300 cubic millimetres per minute at 4kW loading. In the third range, using random frequency, the maximum metal removal rate is 100 cubic millimetres per minute.

With a 4·5kW generator the first range at a controlled frequency 100 c/s gives a maximum metal removal rate of 400 cubic millimetres per minute with 4·5kW loading. The other two ranges at random frequency give a maximum metal removal rate of 150 cubic millimetres per minute with 3kW loading, and 100 cubic millimetres per minute with 2kW loading.

Industrial and Labour Notes

Industrial Fuel Efficiency

At the fifth annual meeting of the National Industrial Fuel Efficiency Service, which was held in London yesterday, the chairman, Sir Leslie Hollinghurst, said that the value of the organisation's work was increasing every year. A great deal of that work was with heavy industry and the textile industry. The services of N.I.F.E.S. engineers last year, Sir Leslie remarked, were even more in demand than hitherto in those sections of industry which were the hardest pressed. Visits to factories and other establishments last year, for all services, numbered 12,749, representing a 10 per cent increase on the preceding year.

Sir Leslie went on to say that the experience of the first five years of N.I.F.E.S. had made it perfectly plain that there was great scope for the work to be of real service to British industry. Experience had shown that the average factory, consuming from 500 to 5000 tons of fuel yearly, could readily reduce its fuel costs by 15 to 20 per cent. Previous surveys had demonstrated beyond any doubt that the efficiency with which coal was being burnt under industrial boilers was very low ; the survey of last year showed how the efficiency of those same plants had been raised and how it was being maintained at a much higher level under N.I.F.E.S. regular service. That, Sir Leslie claimed, was entirely due to the expert engineering control provided by the organisation in circumstances where it would be uneconomic for the industrialist to employ his own specialist staff.

Professional and Technical Civil Servants

The report of the Civil Service Commissioners for the year ended March 31 last comments on the continued shortage of good engineering candidates for the " works group of professional classes " as well as for analogous professional posts. The report says that, during the year, there was a decline in the number of applications received and a tendency, particularly in the competitions for mechanical and electrical engineers, for the number of vacancies to increase. In those competitions, the Commissioners report, they succeeded in filling less than half the vacancies. The reorganisation of the War Department Works Directorate caused increases last year in the demand for architects, civil engineers and quantity surveyors, but it was possible to find only a few recruits from the small number of candidates who applied. Grave shortages also remained, the report adds, in the telecommunications and other electronic fields.

British Constructional Work Overseas

According to information published by the Board of Trade, British contractors carried out construction work overseas to the value of over £120 million in the twelve months ended March 31, 1959. That was about £6,000,000 more than in the preceding twelve months and was the highest figure since the Ministry of Works started its annual survey in 1954–55. More than sixty firms, it is stated, were active last year in about sixty-five different countries.

The value of work outstanding in March was nearly £124 million or £2,000,000 more than a year earlier. The slight fall in the value of new contracts obtained can be attributed, it is thought, to fewer large contracts being placed during the period. There was a similar fall in 1956–57, but that was more than made up in the following year. At present, it is stated, the value of outstanding orders is higher than it has ever been. During last year, British firms began work in a number of fresh countries, notably in the Fiji Islands, Gambia, West Germany, Holland, Japan and South West Africa. In addition, large orders were obtained, though work on them has not yet been started, in Borneo, Guernsey, Mauritius and Singapore. There was an increase last year of over £8,500,000 in the value of new contracts obtained in Commonwealth countries throughout Africa and the value of outstanding orders there at the end of last March was nearly £13,000,000 higher than at the end of the preceding year. Particularly noticeable increases in new orders occurred in the Central African Federation, Nigeria and the Union of South Africa. During last year about £40,000,000 worth of work was carried out in the African countries of the Commonwealth, the largest amount in one country being £9,000,000 in Ghana. British civil engineering contractors were also working in French and Portuguese colonies in Africa.

During the year, British contractors obtained new orders worth about £7,500,000 more than in 1957–58 in Brazil and £6,000,000 more in Iran. These and the increase in orders from Africa largely offset the somewhat lower level of orders from the rest of the world. In the dollar area, which is accounted for almost entirely by Canada, the position remained fairly steady, with a slight drop in new orders last year. The orders at present in hand in the area represent approximately eight months' work.

Training Services in Industry

The Industrial Training Council has produced a useful booklet, entitled *Training Services in Industry*, which gives some account of the development of training services by employers' organisations and quotes examples from twenty or so major industries. The booklet recalls that, up to the end of the second world war, the training of workpeople was essentially a matter for individual firms ; there was virtually no co-ordination at industry level. Employers' organisations, concerned with the protection of their members' interests, confined their activities in this field mainly to the provision of advice as and when it was sought by their members. But, the booklet shows, modern trends towards greater complexity and swifter change in industrial methods, coupled with the condition of full employment and the imperative need to make the fullest use of the available manpower, require a greater degree of central co-ordination in all labour matters. Moreover, the urgent problem of the " bulge " in school leavers in the early 1960s underlines the need for a central lead in each industry in training matters.

The booklet also points out that the appointment of full-time training officers to promote an industry scheme either at national or local level, to provide technical advice as consultants and to provide the expert link between the firms in the industry and organisations outside it, has been a logical development. The work of training officers, it is claimed, greatly facilitates the provision of continuing assistance and advice designed to meet the practical requirements of individual firms.

Copies of the booklet (1s. 6d., including postage) may be obtained from the Industrial Training Council, 36, Smith Square, London, S.W.1.

Iron and Steel

The Iron and Steel Board's monthly report says that, during August, pig iron production averaged 219,600 tons a week, which was 1400 tons below the average for August, 1958. Crude steel production, on the other hand, averaged 337,100 tons a week in August, an increase of 13 per cent over August, 1958. August is a month, of course, in which the effect of annual holidays is always noticeable. The rise this year in steel output reflects a continuation of the strengthening demand for many products.

The Board states that, in the second quarter of this year, stocks of finished steel in consumers' and merchants' hands are estimated to have fallen by 196,000 finished tons. Stocks in the public sector fell more than those in the private sector, shipbuilding and general engineering showing the largest fall in the latter. But stocks of steel held by the motor-car industry and the building industry have increased. Provisional figures collected by the Board show that, in the second quarter, there was an appreciable increase in the total of steel consumption. After adjustment for seasonal movements, steel consumption fell each quarter after the third quarter of 1957 until the beginning of this year. Total consumption in the second quarter of this year, estimated at 3,375,000 tons, was much the same as in the second quarter of 1957. The proportion of the various steel products within the total has changed, however, sheet and tinplate and light products generally forming a larger part.

Civil Engineering Safety Training

A safety training course, stated to be the first of its kind, for men engaged in civil engineering contracting work, has been held recently at the Birmingham Industrial Safety Training Centre. The course was arranged with the co-operation of the Federation of Civil Engineering Contractors and was attended by twenty-three men. The subjects covered included legal provisions and safety requirements on construction works ; site tidiness ; soil characteristics and timbering ; safe working conditions and the human factor in accidents ; electrical accidents and lifting and carrying. During the course, it was pointed out by an insurance company's official that the humanitarian aspect of safety was obvious and that accident prevention was sound business. In 1957, he said, civil engineering and building contractors had spent about £100 million on insurance premiums. The hidden cost of accidents, representing loss of production, extra overheads and so on, was, however, far greater, being in the ratio of about 4 to 1 to insurance premiums.

The course is to be repeated at Birmingham next month and similar courses are imminent at the Enfield Training Centre. All these courses, it is stated, are now fully booked.

European Machine Tool Exhibition

No. I

THE products of nearly a thousand firms from the machine tool manufacturing countries of Europe are on show at the sixth European Machine Tool Exhibition which opened in Paris on September 12 at the Centre National des Industries et des Techniques. As in previous exhibitions of this kind, Germany is represented by the largest number of firms with 330 exhibitors, who occupy just under 14,000 square metres of stand space. French manufacturers come next with 315 firms, occupying stands totalling 10,300 square metres, followed by Switzerland with 97 firms, Italy with 90 firms, Great Britain with 64 firms, Belgium with 25 firms, Sweden with 20 firms, Austria with 12 firms, and Netherlands with 10 firms.

For this exhibition it has been necessary for the organisers to limit the weight of individual machines to 40 tonnes, in order to comply with the restrictions imposed by the permitted intensity of floor loading and the capacity of the handling and other facilities available. Although reasonably large machines are generally within these weight restrictions, a number of makers of very heavy plant have expressed dissatisfaction at not being able to exhibit representative plant from their ranges. Despite these restrictions, however, this show, like the previous European Machine Tool exhibitions, provides a good insight into the general trend in development.

An increasing number of manufacturers, particularly of lathes and milling machines, are building into their equipment programming devices for carrying out complete automatic machining cycles at high speeds and to very close tolerances. It is claimed that on many machines so equipped quite small batch production can be economically programmed, whilst the basic machine efficiency is not in any way affected when it is required for individual part production using manual control. To speed and facilitate machine changes between cuts an increasing number of machines are being arranged with push-button control and means for the preselection of feeds and speeds. In connection with control equipment considerable interest is being shown in the electronic control systems for high precision machines which have been developed by British firms. It is evident at the exhibition that no Continental manufacturers have yet developed equipment which in any way competes with the class of British equipment and that in the electronic control of machine tools Great Britain is far ahead of other countries.

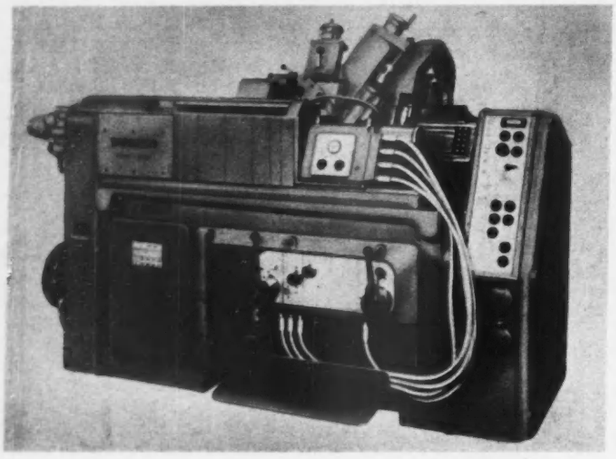


Fig. 1—Lathe with six-cycle automatic attachment and automatic feed control—Dubied

Component loading and unloading devices and magazine feed units are being introduced on an ever-widening range of standard types of lathes, automatics, copying machines, gear cutters, &c. These devices are in many cases suitable for use in conjunction with transfer equipment to enable in-line production of components over a complete sequence of operations. Automatic gauging equipment with " feed back " facilities now available for use on machines and production lines provide a constant check to compensate for tool wear and maintain close tolerances at all stages in production. As in all machine tool exhibitions of recent years there are shown a number of special-purpose transfer machines fitted with unit heads for drilling, boring, tapping, milling and other operations on components for the motor-car industry.

Interesting demonstrations of the " 517 " automatic lathe introduced some two years ago by Edouard Dubied and Cie, S.A., Neuchatel, Switzerland (Wickman, Ltd., Coventry), include a machine with a six-cycle automatic attachment and automatic feed control, and two lathes coupled by a transfer unit for completing two machining stages on a motor shaft. These lathes of unit design are made in four models with different feed and speed ranges to turn components up to 5½in diameter between 20in centres.

The lathe shown in Fig. 1 incorporates the six-cycle attachment and automatic feed control system, and on it a complete turning cycle is carried out on a component on depression of the start button. Through the control panel on the right-hand side of the machine there can be arranged machining cycles involving copy turning and plunge cutting with four tools on one or two attachments in various sequences. Other controls enable the preselection of turning with or without a coolant supply ; the use of automatic feed control in which three different cutting rates can be used in any desired sequence, and the speeds of infeed and return of the plunge cutting attachments. A slotted plate on the top towards the rear of the machine carries a series of adjustable contacts through the setting of which are controlled the initiation of rapid traverse and feed speeds, operation of the plunge cutting devices, switching in of automatic feed control, and final stopping of the machine at the end of a cycle.

One of the two lathes fitted with automatic loading and transfer equipment can be seen in Fig. 2. The conveyor unit provides an indexing magazine timed to move in accordance with the machining cycle to present blanks as required and remove finished parts. The loading device comprises a pair of pivoted arms mounted on a slide at the rear of the lathe and carrying work jaws. One arm is used for removing finished components from the lathe and the other for inserting blanks and on their slide the arms are carried between the turning station and the indexing conveyor. All movements of this device are controlled electro-hydraulically and timed in unison with the machining cycle of the lathe. The jaws of the unloading arm are coupled to a measuring instrument, which, through a feed-back mechanism, adjusts the tool slide setting when necessary.

In the loading cycle when the lathe spindle has stopped the unloading arm swings down and its jaws close over the component to check it on one or more diameters and, if necessary, a tool slide adjustment is made. The jaws then remove the component as it is unclamped in the machine and the unloading arm swings up. The loading arm then swings down to place a blank between its jaws in the chucking position and when the part has been clamped swings up again. It is stated that this sequence of operations is completed in between fourteen and sixteen seconds. Whilst the machine then proceeds to turn the fed component the jaws are carried along their slide to register over the feed magazine. The unloading arm deposits the machined component on the magazine and swings up. The magazine then indexes one division to position a blank for the loading arm, which picks it up before the arms are returned on their slide to the loading position ready for the next cycle of operations.

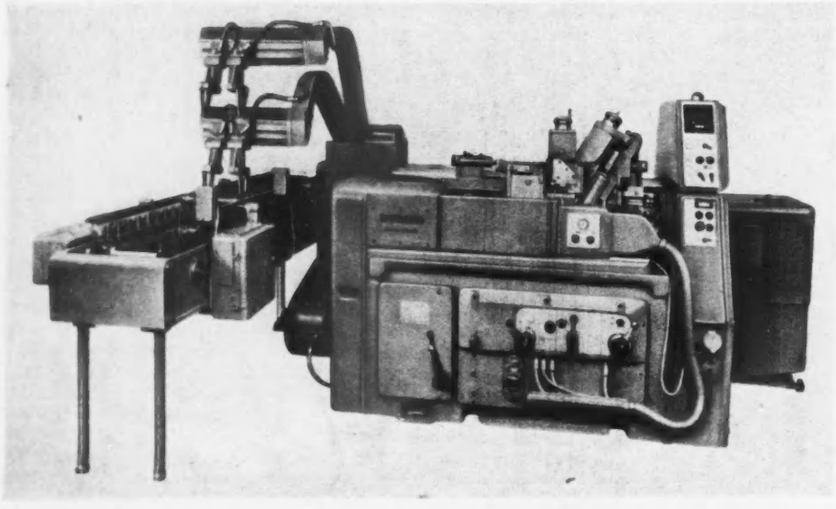


Fig. 2—Automatic cycle copying lathe with component transfer and leading equipment—Dubied

As at previous European Machine Tool Exhibitions an interesting selection of centre, copying and turret lathes is to be seen upon the stand of the three Vereinigte Drehbank-Fabriken firms —Gebr. Boehringer G.m.b.H.; Heidenreich and Harbeck ; and H. Wohlenberg, K.G. The two copying systems developed by this group—the " Unicop " and the " Hydrokop " —are demonstrated in production on several machines, including the " Polycop " lathe illustrated in Fig. 3. On this machine with the " Unicop " copying system longitudinal and transverse as well as external and internal copying can be effected. It has a transverse copying traverse of 8¾in for facing operations, and covers the full swing capacity of the machine. Using the full-length clamping slots in the long

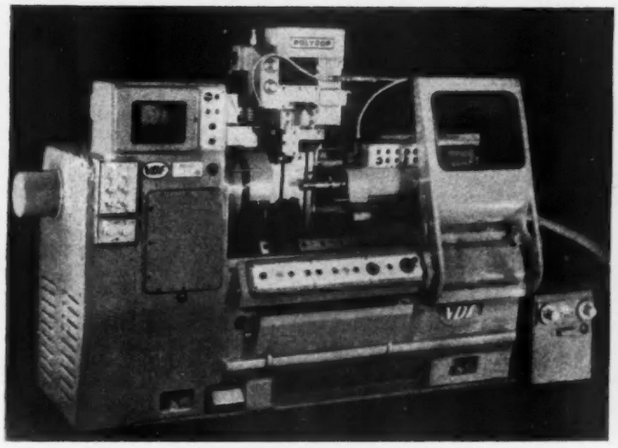


Fig. 3—"Polycop" lathe with longitudinal and transverse copying—V.D.F.

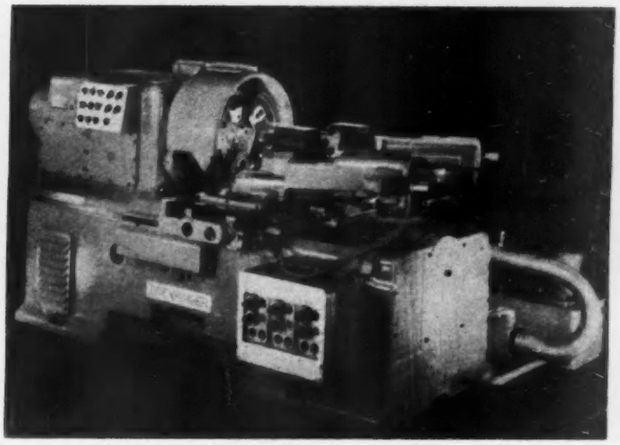


Fig. 4—Special purpose lathe for fittings up to 31½in diameter—V.D.F.

cross slide, tools can be arranged to follow each other in a follow-on copying process, incorporated in the template or trip-controlled automatic work sequence. In cases where several tools must follow one another, it is also possible to mount a turret head on the cross slide. This turret operates with three different sets of tools controlled from automatically indexing templates through trip dogs. In addition, a turret or boring slide can be fitted in place of the tailstock and can also be incorporated into the automatic work cycle of the machine. An addition to the "Polycop" equipment is a hydraulically-operated swivel slide on which plunge-cutting or facing tools can be mounted anywhere along the entire turning length of the machine for producing recesses or similar work.

Amongst the special purpose machines of this group is the Boehringer lathe, shown in Fig. 4, for components such as pipe and valve fittings. It turns work up to 31½in diameter and is equipped with two separate cross slides on the carriage. These slides have independent feeds which are infinitely variable between 0·003in and 0·03in per revolution and rapid traverses up to 6½ft per minute. All slide movements are through hydraulic motor-driven screws and nuts and a copying attachment is fitted on the rear cross slide. An automatic preselected work cycle is controlled electro-hydraulically through the setting of limit switches and trip-dogs on the machine.

A high-speed turret lathe equipped with hydraulic controls and automatic sequence selection of speeds and feeds, known as the "Leromatic 36," is shown by Boley and Leinen, Esslingen-Neckar, Germany (Elgar Machine Tool Company, Ltd., 172, Victoria Road, London, W.3). This machine takes bar stock up to 1·41in diameter, or chucking work up to 2·16in for turning and drilling or 3·93in for drilling only. It has a stepless range of spindle speeds up to 2500 r.p.m. in the clockwise and 1500 r.p.m. in the anti-clockwise direction.

On the turret head of this machine the tooling is arranged in two groups—an eight-station turret for turning tools and a four-station drilling head which takes drills, reamers, turning and screw-cutting tools. With standard tool holders thirteen operations, including a work stop, can be covered on the machine and, if required, copying operations can be included in the machining cycle.

The turning tool turret head and the drilling head are mounted on a common shaft and have a steplessly variable feed in each direction from 0·02mm to 0·7mm per spindle revolution. This feed motion is hydraulically operated and, further, the tool turret head has stepless feeds from 0·001mm to 0·35mm per revolution for facing operations. The required feeds and speeds can be preselected for positions of the turret or drilling head and these rates are automatically engaged when the heads are indexed during a machining cycle.

One of the single spindle automatics shown in operation by B.S.A. Tools, Ltd., Kitts Green, Birmingham, 5, is fitted with a new work spindle positioning attachment which stops the spindle and locates the chuck jaws in a definite position in relation to the tooling. This enables bar stock of special section to be located and cross-drilled or saw slotted precisely where required; and allows the location of chuck jaws at a station for the feeding of components of special shape from a magazine.

The attachment comprises three separate parts—a work spindle brake, a friction wheel which is driven at a constant speed by gears from the machine backshaft, and a locating

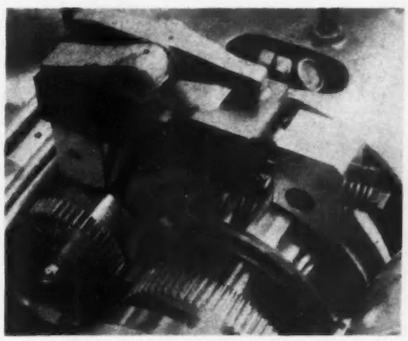


Fig. 5—Work spindle brake and positioning attachment—B.S.A.

plunger. These parts work independently from each other so that the time required to locate the work spindle can be adjusted. The attachment can be seen in Fig. 5 and its operation is as follows: at a given point in the machining cycle the work spindle is tripped into neutral and the spindle brake immediately comes into effect. When the spindle has stopped the brake is released and the constantly rotating friction wheel is brought into contact with the spindle to revolve it in a clockwise direction. The locating plunger is advanced on to the face of the locating ring and drops into its slot to stop the spindle when the chuck jaws are in position for the cross machining operation or the work removal and loading operation when a magazine feed is fitted.

At the completion of the operations the locating plunger is released for the machining cycle to be restarted. The three parts of the attachment are operated by pneumatic cylinders with actuating valves controlled by cams on a drum on the front camshaft of the machine. These cams have means of independent adjustment to permit the positioning operation to be timed within the machine cycle.

For the exhibition the attachment is used in conjunction with a "Valco" bowl feeder delivering hot brass stampings to the automatic. On the machine the cycle of operations begins with the countersinking of the cored hob. After indexing of the turret a 1·218in diameter is turned, and simultaneously, a combination drill is fed into the piece to produce a 0·453in diameter hole and the bore for threading a 0·625in hole.

During this operation a circular form tool on the rear slide is fed in to face the front of the component and chamfer the outer edge in preparation for machining external threads.

The speed and direction of the spindle is then changed for cutting the two external threads, one 1·505in diameter and the other 1·218in diameter, a combined tool in a thread cutting attachment mounted on the front slide being used for the threading operation. Simultaneous with this thread cutting, internal recessing is performed from a turret holder operated by a guide plate attached to the rear slide circular form tool post. The final machining operation is the tapping, from the turret, of the previously drilled 0·625in diameter bore. Following this the chuck jaws open to allow a spring-loaded ejector to eject the component against a leather-faced buffer held in the turret. For this component set up the spindle speeds used for machining are 1440 r.p.m. for left-hand and 582 r.p.m. for right-hand rotation, the complete cycle time being twenty seconds.

The amount of space allocated for the stand of C.V.A. Jigs, Moulds and Tools, Ltd., of Hove, Sussex, is insufficient for the firm to show a fully representative range of its machines, and charter flights have been arranged to take visitors from Paris to the works to see certain other machines during the course of the exhibition. One of the machines exhibited, however, is the "Powerturn" copying lathe shown in Fig. 6. This machine is made in three models to swing 13in, 16in and 20in with five different bed lengths. It has a preselector headstock on which a single dial is used to compute and preselect up to six changes of spindle speeds. On the dial the required surface speed is set opposite the workpiece diameter and a speed change is effected by moving a clutch and brake lever first to the brake position and then to the shift position, when the headstock gears are shifted by an electric hydraulic mechanism. An instantaneous changeover can be made to tracer control and tracing can be effected either towards or away from the headstock. Rapid traverse at 40in per minute is available for both the saddle and the cross-slide motions through a single lever.

One of the firm's "Mil-Waukee-Mil" milling machines is fitted with "Dial-a-Cycle" programming control. With this control each sequence of machine functions is controlled by a multi-selector phase switch, successive functions being initiated by trips. It enables an operator to read the sequence of functions from a drawing and simply dial each on successive phase switches to constitute a complete automatic cycle.

A turret drilling, tapping and boring machine has been equipped by C.V.A. with the E.M.I. numerical control system. On this machine a

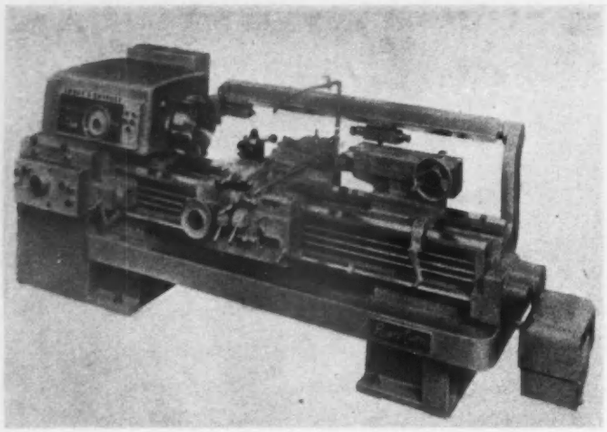


Fig. 6—Copying lathe with preselector for changing spindle speed—C.V.A.

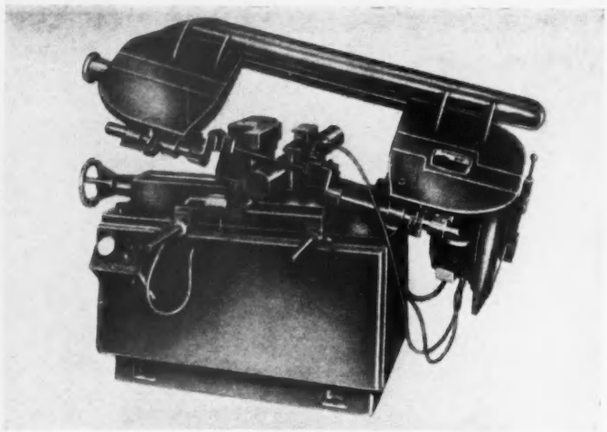


Fig. 7—Automatic band saw for material up to 9in diameter—Qualters and Smith

six-spindle indexing tool turret operates over a compound saddle with a 34in by 24in worktable servo-controlled in the longitudinal and transverse directions. The hydraulic vertical feed of the turret is electrically preselected from six preset rates, and the three spindle speeds available are also electrically preselected. It is stated that the controlled slides on this machine have a positional accuracy of ±0·001in.

A C.V.A.-Kearney and Trecker vertical milling machine equipped with Ferranti numerical control for three-directional continuous milling operation is also being demonstrated by the firm. It is stated that on this machine the displacement of slides can be monitored to within ±0·0002in by the optical position identifying units attached to the three moving members, and that positional accuracies in the order of ±0·0005in can be obtained.

A cylindrical grinding machine shown by Schaudt Maschinenbau G.m.b.H. of Stuttgart (Burton Griffiths and Co., Ltd., Kitts Green, Birmingham, 33) is designed to facilitate the cutting down of machining time if besides a diameter a shoulder also has to be ground, or if a profiled wheel is used for grinding considerable depths. The machine has an angular wheelhead and the grinding wheel is arranged on the spindle at the right of the workhead. The profile dressing attachment for the grinding wheel works from the left to the right and the automatic grinding wheel infeed is carried out in the direction of the angular position of the workhead. This construction affords an advantage by enabling face grinding to size without traversing the table longitudinally and promotes grinding wheel economy.

The machine is also equipped with an automatic dressing attachment, which determines the start of wheel dressing, according to preselection, after a certain quantity of components has been ground. The dressing operation itself is automatic, i.e. the diamond effects several dressing strokes, infeeding against the grinding wheel at each stroke. The number of dressing strokes can also be preselected. An electronic sizing and controlling attachment has a contact-free sizing head which is seated on the table. The head is swivelled to the component automatically by hydraulic means, passing the diameter change on the component to an amplifying and registering device, which sends out the impulse for controlling the work cycle.

A new product of the Kerry Group of companies is an automatic bandsaw (Fig. 7) made by Qualters and Smith Brothers, Ltd., Barnsley, Yorks. It can be used either as a manually controlled machine or set for an automatic controlled cutting cycle. It has a capacity for material from ¼in to 9in diameter, or 6in square and a cutting speed ranging from 80ft to 250ft per minute. The saw blade is driven through a reduction gear and a variable speed gear by a 1½ h.p. motor mounted on the back of the frame, and the rate of feed is controlled by a hydraulic cylinder which also raises the frame at the end of a cut.

For the "draw-in" roller vice the front bracket has four rollers which are driven through a worm and wheel by a ½ h.p. motor. Four "idler" rollers are mounted on the rear, fixed bracket and a limit switch on this bracket stops the machine when the bar stock is exhausted. In the automatic cycle the bar stock is clamped by a handwheel between the vice rollers, and when a piece of stock has been cut through the frame contacts a limit switch. The hydraulic ram raises the frame and a second limit switch starts the vice feed roller drive. This drive is stopped when the end of the stock contacts a stop bar switch and the cutting cycle restarts automatically. A control panel at the front of the machine has individual buttons for the operations when it is required to use the machine for individual operation. Coolant is delivered to the blade from a tank in the base by a self-priming pump driven at a constant speed by the main motor.

(*To be continued*)

International Motor Show at Frankfurt

No. I

THIS year's "Internationale Automobil Ausstellung" at Frankfurt-am-Maine, which was opened on September 17, is the thirty-ninth German motor show and the fifth organised after the war. The show, which presents motor-cars as well as commercial vehicles, is staged in biennial intervals, as the present, mainly evolutionary, phase of automobile engineering does not seem to justify the technical effort nor the expense of an annual exhibition.

The German motor show, scheduled ahead of the Paris Salon and the London Motor Show, provides the first of the three big International automobile exhibitions which can be seen this autumn. The Frankfurt show has an entirely International character: not less than thirty-seven German and forty-four foreign motor manufacturers are presenting an impressive display of motor-cars and commercial vehicles, thus giving the opportunity of comparing at first hand the relative merits of the various nations' automobile design, their price, appearance and—last not least—their sales appeal, particularly to the customers of the European market.

This year's show is on an even grander scale than the 1957 show and comprises twenty-three halls and pavilions, covering a floor space of about 17·5 acres; a further 7·5 acres of open-air parks are allotted to heavy vehicle demonstrations and to all sorts of equipment in actual operation. In view of the considerably increased number of foreign exhibitors the distribution of floor space to individual firms has been generally curtailed; nevertheless the large German manufacturers like Daimler-Benz, Volkswagen, Ford, Auto-Union and Bosch still maintain their own exhibition halls, and fully utilise this opportunity of presenting their products with an air of efficient showmanship.

Reference has already been made to the strong representation at the show of foreign motor manufacturers who—in case of motor-cars—actually outnumber the German manufacturers by almost 200 per cent. Indeed, there is hardly any car-producing factory in the world (including the Soviet Union) which is not represented by at least two of their different makes. There is, however, a noticeable difference between this year's show and those of the past years: the presence of foreign cars at the German shows used to be mainly a matter of prestige, for the actual imports into Germany of foreign cars were almost negligible and were generally restricted to members of the Allied Forces stationed there. In view of the steadily increasing mutual exchange of consumer goods between the O.E.E.C. countries it is obvious that Great Britain in particular should take steps to encounter the powerful influence of the automobile industries of the European Common Market countries, especially that of Western Germany, on the structure of the European Trade Area. Last year Germany exported 117,487 motor vehicles to the E.C.M. countries—mainly to the Benelux countries—and 240,738 to other European Countries. The equivalent figures of the British exports to these countries were 29,669 and 73,616 vehicles respectively. The total exports of the automobile industries of Germany, France, and of Italy to the O.E.E.C. countries amounted to 541,140 vehicles, those of Germany alone to 357,865 units, while the equivalent exports from Great Britain comprised only 103,225 vehicles. It appears that the European market, hitherto rather neglected by the British motor industry, has become increasingly important. In most European countries the number of cars per head of the population is considerably smaller than in Great Britain, and there is reason to believe that the demand for motor vehicles will grow at an ever-

increasing rate. With the gradual lessening of import and currency restrictions and the reduction of import duties, which on the Continent are generally lower than in Great Britain, most European countries could become a potential market for the British motor industry. This applies not only to those European countries without a motor industry of their own, but also to France, Germany and Italy where some types of British cars might sell quite well, providing they possess certain qualities, generally not provided by the respective national industry, or offer definite advantages in respect to appearance and performance. It can be assumed that such considerations might have influenced British motor manufacturers in their decision to be represented at Frankfurt by a strong contingent of fourteen makes, including most of the prominent models of the British Motor Corporation, Standard, the Rootes Group and, further, by such individual firms as Aston-Martin, Ford, Jaguar, Rover and, for the first time, Rolls-Royce. The fact that some of the latest British models like the new Austin 7 and the Triumph "Herald" have recently adopted constructional principles which on the Continent are considered essential in small-car design, should prove helpful to promote increased sales.

It is evident from the few statistical references already made that the German automobile production is in a very strong position, the present production running at the rate of about 6200 vehicles per day, about 13 per cent more than the British industry. Since the middle of 1956, when German production first surpassed British, Germany has been able to maintain the lead and to-day is still not only the largest automobile producing country outside the U.S.A., but also the world's greatest exporter of motor-cars. The steady growth in productivity is presented in Table I, showing the German production and export figures for the first seven months of this year, compared with those of the previous year. The table also shows the corresponding figures of the British industry.

In contrast to Great Britain, which ships most of her automobile production to Commonwealth countries and to U.S.A., Germany relies mainly on the European continent which absorbs about 50 per cent of her motor exports. Other export markets are Argentine, Brazil, South Africa, Canada, and the United States of America. In the latter market, however, sales have dropped to a certain extent in favour of increased imports from Great Britain: imports in the first three months of this year amounted to 49,120 from Great Britain and 51,119 from Germany.

The expansion of the German automobile industry, which has been going on incessantly for the last five years, is undoubtedly connected with the growing prosperity of the country. A constant demand in the home market, stimulated by full employment and by the feeling of social security among the working population, has kept the factories running at full capacity ; in spite of the fact that in the first half of this year 6,000,000 workers have received an average wage rise of about 5 per cent, prices have remained remarkably stable. Though manufacturers are generally optimistic and hope that by further effort the export rate can still be increased, there are many economists who express concern that the accelerating expansion of the economy might weaken the purchasing power of the Deutsche Mark.

At present, however, there are no indications that any slackening of the industrial activity is imminent. Admittedly, the motor industry has to put up with certain difficulties, inherent in any over-expansion, such as the growing scarcity of skilled labour and the shortage of certain raw materials, in particular of rolled steel plate ; most manufacturers, however, are convinced that these difficulties will be overcome, and they base a great deal of their optimism on the satisfactory working of the newly established European Common Market. The same confidence is expressed by leaders of the trade unions who have played an important part in promoting good industrial relations between the managements and the workers. Thanks to their efforts the German motor industry has been notably free from such productivity-affecting disturbances as restricting practices, unauthorised strikes and unreasonable wage demands, factors which, in this country, have done considerable harm to industrial output.

TABLE I—*Production and Exports of Motor Vehicles for the First Seven Months of* 1959 *Compared to* 1958

(*a*) German (exports in 1959 : 51·2 per cent of total production).

(*a*) Germany	Motor-cars*		Change, per cent	Commercial vehicles†		Change, per cent	Total		Change, per cent
	1959	1958		1959	1958		1959	1958	
Production	823,921	745,071	+10·5	121,266	104,333	+16·3	945,197	849,404	+11·3
Exports	434,298	368,194	+17·7	53,299	46,870	+12	487,597	415,064	+17·0

(*b*) Great Britain (exports in 1959 : 49·3 of total production).

(*b*) Great Britain	Motor-cars*		Change, per cent	Commercial vehicles†		Change, per cent	Total		Change, per cent
	1959	1958		1959	1958		1959	1958	
Production	639,473	636,137	+0·5	193,495	189,653	+4·8	837,968	825,790	+1·4
Exports	336,086	301,008	+11·2	74,657	72,921	+4·6	410,743	373,929	+10·0

* Including dual-purpose cars. † Including buses and road tractors.

One should expect that any noticeable change in the social structure of the markets, especially the increased purchasing potential of customers in Germany and her main exports market, would find its expression in the class, price and size of cars produced in the last few years. Table II,

TABLE II—*Production of Motor-Cars in Germany for the First Seven Months of* 1952 *Compared to* 1958

	1959	1958	Change, per cent
Passenger cars	739,028	673,373	+9·8
Up to 500 c.c. cylinder capacity	24,784	45,942	−46·1
From 500 c.c. to 1 litre cylinder capacity	107,107	93,247	+14·9
From 1 litre to 2 litres cylinder capacity	579,095	503,948	+14·9
Of more than 2 litres cylinder capacity	28,042	30,236	−7·3
Dual-purpose cars	84,893	71,698	+18·4
Total	823,921	745,071	+10·5

showing the German production of motor-cars in the first seven months of this year compared with that of the previous year, does not bear out this assumption. The number of the more expensive class of cars, i.e. those of more than 2 litres cylinder capacity, has actually decreased by 7·3 per cent (in spite of the steadily increasing total production it has been almost stationary since 1956), a fact which can be taken as an indication that in this particular class the market, at least temporarily, has approached saturation point. Remarkable, but entirely in accordance with the general tendency prevailing in the last few years, is the fact that the number of cars between 1 litre and 2 litres capacity has gone up at a higher rate than that of the total production, an indication of the growing demand among the professional and middle classes, tradesmen and the higher-paid workers. It appears that the modern medium-sized, four to five-seater family saloon, fitted with a four-cylinder engine of something between 1·5 litres and 1·9 litres capacity and a specific output approaching about 50 h.p. per litre, provides satisfactory performance and comfort and gives all the speed which can be safely attained on Continental motor roads. Cars of this category comprise more than 80 per cent of Germany's total car production.

A rather surprising phenomenon is the reduction in the number of "baby-cars," i.e. those vehicles of unorthodox shape like the so-called "bubble-cars," vehicles generally powered by single or twin-cylinder, air-cooled, two-stroke engines of less than 500 c.c. capacity. It must be admitted that, with the appearance of cars fitted with 0·6 litre air-cooled, twin four-stroke, more customers are now changing over to this type of vehicle, but, even so, it is evident that, compared to last year's output, the output of cars of less than 1 litre capacity has dropped by about 5·5 per cent. It seems that the former tendency of many motorists of turning from the motor-cycle and the motor-scooter in the sphere of everyday transport towards a small utility vehicle, offering full weather protection and reasonable accommodation, is now changing ; customers have become more discerning and, anxious to "keep up appearances," are reluctant to accept utility vehicles unless they comply, in appearance (if not in performance) with the contemporary idea of "what a motor-car ought to look like." Considering that the difference in first cost between the miniature car and the cheapest standard car (in Germany the 1·2 litre V.W.) is comparatively small, other considerations claimed in favour of miniature cars such as lower running costs, road tax and insurance, are now generally considered of secondary importance.

Turning now to a general survey of the tendencies evident at the 1959 German motor show, we notice that practically all the well-established makes of cars show no radical changes in their mechanical layout, but differ from last year's models mainly in improved detail design. The more drastic changes in body styling are obviously influenced by Italian and American trends, characterised by lower roofs, a larger window area, curved windscreens and rear windows, and by long flowing lines tapering towards the rear wings. It must be appreciated, however, that the German stylists have shown considerably more restraint than their American colleagues, and have refrained from indiscriminately copying such fashions as pronounced fins, panorama windscreens which impede the front entrance, and excessive chromium ornamentation.

The fundamental differences between the British and the Continental automobile design are sufficiently known and need not be enumerated in this report. Generally speaking, design has settled down to the following well-established principles : small cars have either front-wheel drive or rear-mounted engines and, with one or two exceptions, are fitted with independent all-wheel suspension, while all bigger cars, apart from those made by American-controlled firms, have independent rear suspensions. The formerly popular air-cooled two-stroke engine (for miniature cars) has almost completely disappeared and has been replaced by the air-cooled four-stroke twin ; the water-cooled two-stroke, however, as a rule the three-cylinder version, is still being made in considerable numbers. Fully automatic transmissions are optionally available for some big, high-priced touring cars, while semi-automatic transmissions with vacuum-operated clutch withdrawal and centrifugal or hydro-dynamic engagement are becoming increasingly popular (in contrast to this country); they are obtainable as optional equipment for many makes. Gear change, generally, has been made easier by further detail improvements to synchronising mechanisms ; synchronisation of all gears, including the bottom gear, is becoming an established fact even for cars in the lower price bracket. Disc brakes, mainly propagated by British makers of accessories, so far have not made much progress in Germany, where designers maintain that the orthodox shoe brake, especially when equipped with finned cast iron-lined light-metal brake drums, cooled by forced draught, is by no means inferior to the disc brake and, being self-energising, requires no servo actuation.

(*To be continued*)

Severin Bridge at Cologne

Another stage in the reconstruction of crossings over the Rhine will be reached when at the end of the year the Severin road bridge is commissioned. Connecting Cologne with the right bank suburb of Deutz, the bridge will relieve the existing Cologne–Deutz Bridge and provide more direct access to the Frankfurt autobahn. At the site selected for the new bridge, the river is some 450m wide, in addition to which the Rheinau river port has to be crossed, necessitating a total bridge length of nearly 700m. The design, selected out of a large number of proposals, achieves the moderate steel requirement of 410 kg per square metre of deck surface, and with only a single pier in the river offers a minimum of obstruction to shipping. An unusual aspect is the use of an asymmetric suspension, carried by a single tower standing on the river pier. This arrangement preserves the view down the river and forms a "counterpoint" to the Dome.

THE widespread destruction of bridges over the Rhine in the last stages of the war produced a major problem for those concerned with the economic reconstruction of the area. In Cologne, two railway bridges with a total of six tracks, and all four road bridges, totalling twenty lines of traffic, were destroyed. With so many calls on the national resources, it is not surprising that by 1957 only fourteen lines of traffic had been replaced ; the traffic volume, however, had increased to 9000 vehicles per day or two and a half times the pre-war figure. The need to expand further the crossing facilities therefore remains, although the building of the Severin road bridge, decided on towards the end of 1955, is a big step forward in alleviating the situation.

The chaotic post-war supply position had important effects on design philosophy in the field of bridge structures. Both labour and materials had to be conserved to the uttermost, and this need led to the introduction or expansion of new techniques as well as of new principles of design.

The widespread application of welding, the use of low alloy steels, of high-duty bolted joints, box girders in place of plate girders, and "orthotropic," specially stiffened bridge decks reduced the weight of steel required in some cases to 45 per cent of what had been considered necessary a quarter of a century earlier. Present-day methods of construction also differ considerably from those used in the past. The work carried out on the site is reduced by prefabrication of entire sections, sometimes of whole spans, which are then placed in position by special derricks or floating cranes. As the Rhine river traffic has increased to an unforeseen extent, it has become very important to carry out any constructional work in a way that will least impede navigation. Accordingly, free cantilever construction is extensively resorted to, and the use of temporary supports in the river avoided as much as possible.

Advances in bridge design may be summarised as the increased use of three-dimensional structures. While such designs offer great practical advantages, these have to be obtained at the cost of a considerably greater expenditure of effort on calculations, which may amount to three or four times that required by bridges designed in the 'twenties and 'thirties.

The decision to build the Severin Bridge in its present form was taken on the basis of a design competition which produced many interesting results.* The group of firms responsible for the design—which bore the code name "Counterpoint"—comprised Gutehoffnungshütte Sterkrade A.G., Butzer A.G., Hochtief A.G., and Strabag A.G. These firms were subsequently entrusted with the construction of the bridge, while the left bank approach ramp was carried out by Wayss and Freytag A.G., Frankfurt-on-Main, and the ramps on the right bank by Dyckerhoff and Widmann K.G., Munich.

The bridge provides a road crossing to the highest German classification (Class 60 according to German Standard DIN 1072) as well as two tramway tracks. Overall width is 29·5m, of which 19m are occupied by the carriageways and the central tramway tracks. On either side of the roadway is a 2·25m wide cycle path and a 3m wide pavement.

Situated about three-quarters of a kilometre upstream from the Cologne–Deutz Bridge, the Severin Bridge crosses the Rheinau river port on the left bank and the entrance to the Deutz river port on the right bank, connecting on that side with the Gotenring boulevard ; an approach road to the Frankfurt autobahn is also projected. The steelwork has a total length of over 690m, of which only some 195m are spanning dry land. To this length must be added the nearly 170m-long approach ramp from the Klappergasse on the left bank and the 172m and 250m-long ascending and descending ramps on the opposite bank, all of which are reinforced and prestressed concrete structures.

The steel weight for the superstructure consisted of 1640 tonnes of "St37" steel, 6000 tonnes of "St52" steel, and 604 tonnes of steel wire for the suspension cables, making a total of 8244 tonnes, or 412 kg per square metre of deck surface. This compares with 630 kg per square metre in the case of the Cologne–Deutz bridge, and 440 kg per square metre in that of the Cologne–Mülheim bridge.

Our pull-out plate shows a plan and elevation of the bridge as well as some characteristic details.

The steelwork comprises two continuous lateral box girders 3·2m wide and varying in height from 3m at the abutments to approximately 4·6m at the centre. The deck is built integrally with the girders of which it forms the top flange, and takes the form of an orthotropic plate stiffened by longitudinal and transverse webs. On the left and right banks, the respective deck gradients are 1·760 per cent and 2·119 per cent, while the centre has a convex curvature of 22510m radius. The six spans amount—left bank to right bank—to 49·21m, 89·03m, 47·81m, 301·67m, 150·68m, and 52·46m, making the total length 690·86m. The bridge rests on the abutments and five intermediate piers, of which the fourth, carrying the suspension tower, is situated some 60m from the right bank.

All foundations are on piles except the tower foundation which is a caisson. For the left bank abutment, 450 Franki piles of 48cm diameter were used, each designed for working loads of 140 tonnes compression and 25 tonnes tension. The two columns of No. 1 pier rest on separate foundations, each consisting of nine Brechtel concrete piles of 48cm diameter for a downward working load of 120 tonnes and an upward load of 35 tonnes. The two tubular steel columns have a diameter of 1·10m each. The second pier has two similar columns each on twelve Brechtel piles, while No. 3 pier has 1·70m diameter steel columns supported on thirty Brechtel piles each.

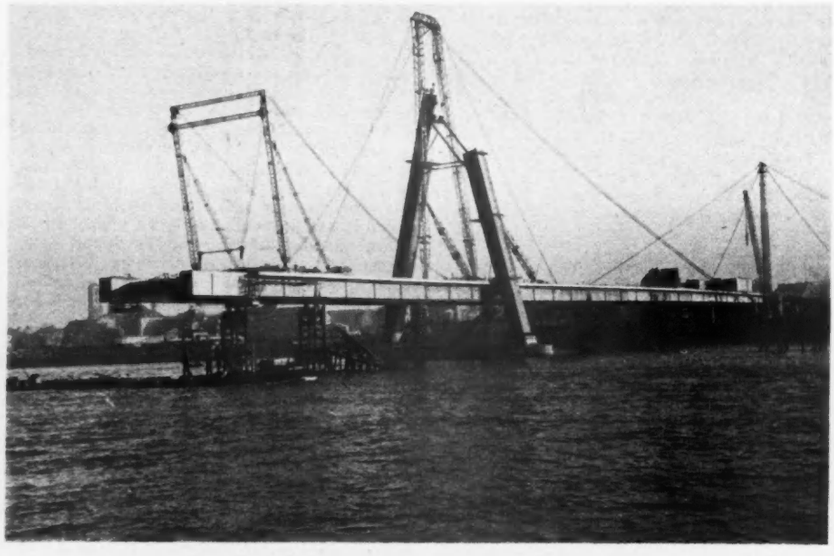
The caisson for the river pier is 59m long and 8m wide and extends to a depth of 6m below the bottom of the river. Pier No. 5, on the right bank, comprises two 1·3m diameter columns which each rest on twenty-five Franki piles. Finally, the right bank abutment is founded on forty-one Franki piles. Spiral staircases at each abutment connect the bridge pavements and riverside roads. The height of the bridge is such that a minimum daylight of 9·10m is left at the highest navigable water level (+43·40m sea level).

The deck plates in general are 10mm to 12mm thick, in some places as much as 25mm. Longitudinal stiffeners take the form of flat ribs spaced at 30cm centres ; transverse ribs are flanged and spaced at intervals of 2m. Along the centre line a 90cm high flanged web is placed with the object of distributing unsymmetrical loads. Torsional rigidity is achieved by transverse plate girders 2·15m to 3·75m high, spaced at intervals of from 43m to 73m.

The whole of the bridge comprises forty-five sections varying in length from 14·34m to 16·16m. The main box girders and deck for each section were welded in the shops, the deck being prefabricated in three parts which were assembled at the site. The girder sections weighed between 25·5 and 69·1 tonnes, and the deck 49·6 to 83·3 tonnes per section. Longitudinal deck webs were welded at the site; while the cross girders and centre web are riveted, as are the erection joints of the main girders.

At the abutments the bridge can move horizontally by ±270mm on the left and ±130mm on the right. Wind loads are transmitted to the foundations at the abutments, at No. 3 pier and at the river pier (No. 4 pier).

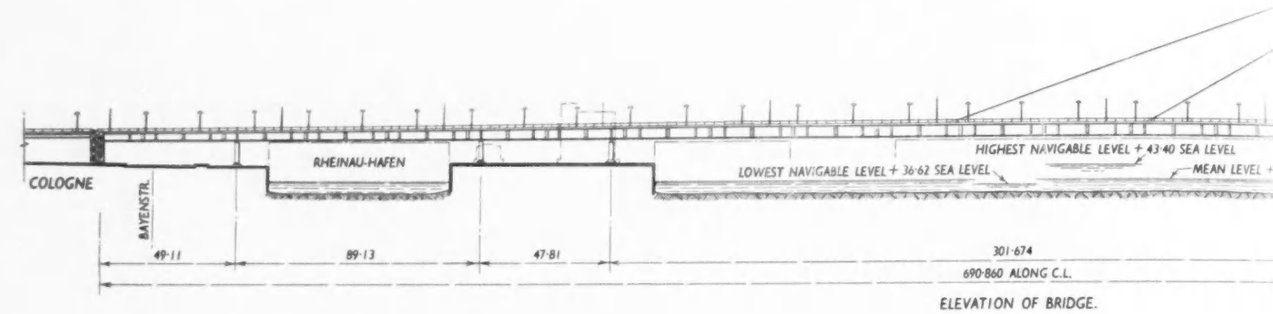
Service mains (electric power and telephone cables) are carried inside the box girders. An



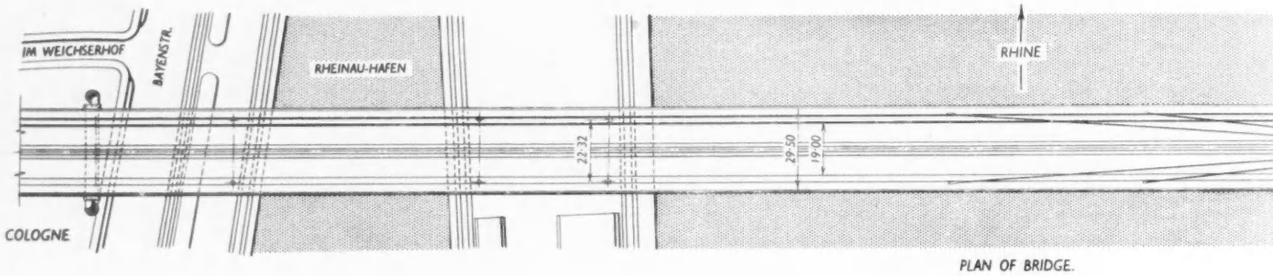
View upstream of the Severin bridge during construction. The tower is partly completed, and the first temporary mid-river support is in position

* "Der Stahlbau," 1957, No. 8, page 205 ; No. 9, page 253 ; No. 10, page 294 ; and No. 11, page 326. The cost of the bridge projects varied between DM.15,000,000 and DM.34,000,000 (exclusive of approach ramps). Tunnels, for which projects were also prepared, would have cost from DM.70,000,000 to DM.124 million

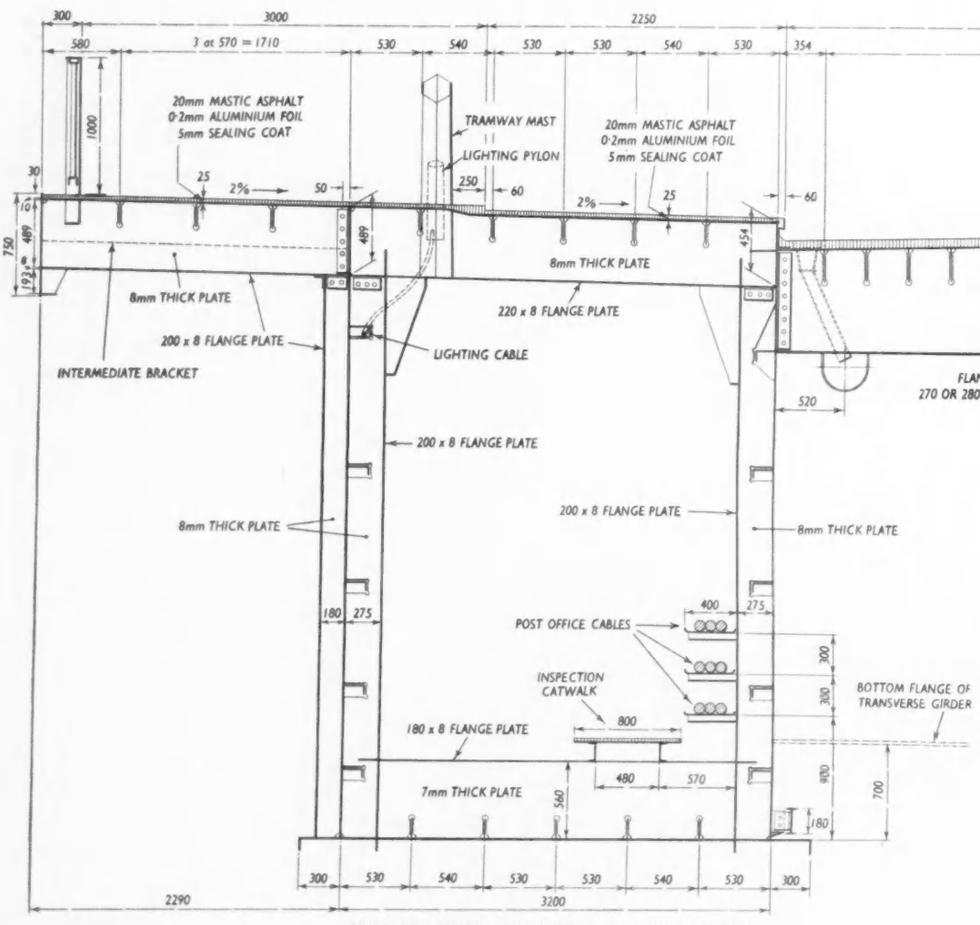
SEVERIN BRIDGE OVER THE



ELEVATION OF BRIDGE.

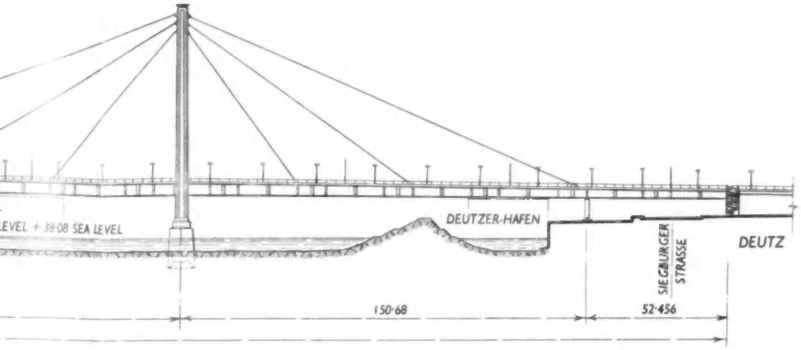


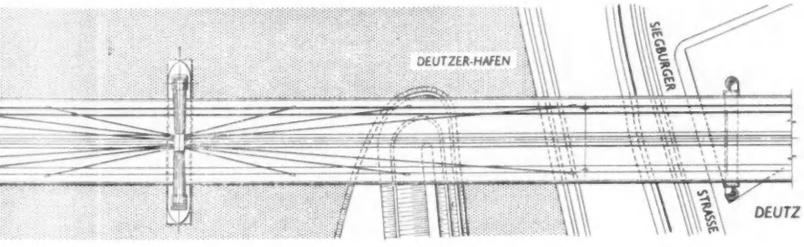
PLAN OF BRIDGE.

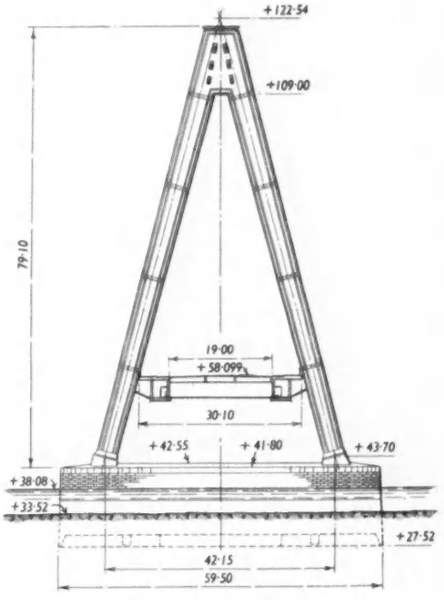


TRANSVERSE SECTION OF DOWNSTREAM HALF OF BRIDGE.

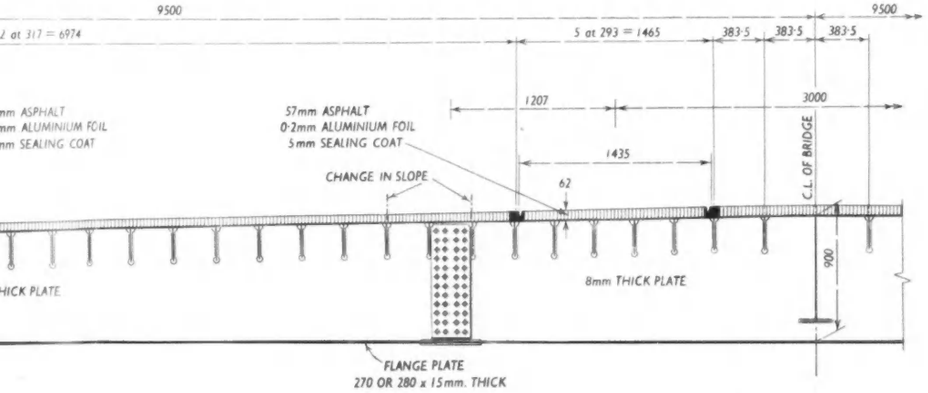
E RIVER RHINE AT COLOGNE

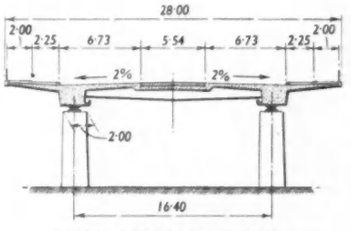




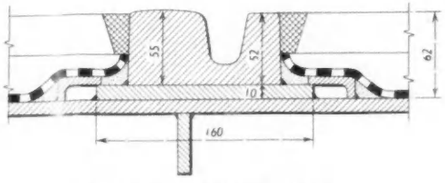


SECTIONAL VIEW AT TOWER.

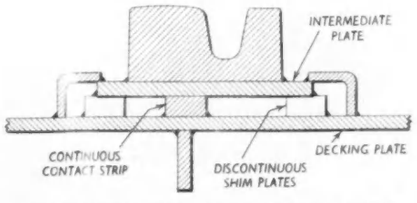




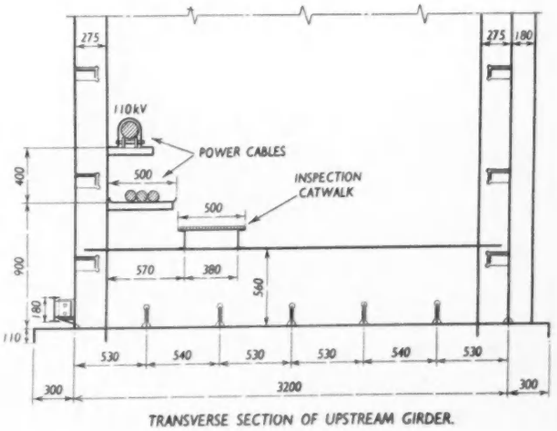
TYPICAL CROSS SECTION THROUGH LEFT BANK APPROACH ROAD.



DESIGN FOR NORMAL BLOCK RAIL.



DESIGN FOR BLOCK RAIL WITH ADJUSTMENT OF HEIGHT.



TRANSVERSE SECTION OF UPSTREAM GIRDER.

underslung carriage facilitates inspection and maintenance.

Tower and Suspension

The single tower which stands on No. 4 pier has the shape of an inverted letter Vee. The two limbs are hollow box sections encastred at the base and rigidly joined at the top. Most of the longitudinal and transverse stiffening webs, which are welded, are placed internally except when architectural consideration made external webs appear preferable. The bridge superstructure rests on brackets connected in the plane of one of the transverse plate girders, by means of universally rotatable bearings.

The legs of the tower measure 3·5m by 4m at the base. The tower is 79·1m high above the pier and approximately 63m above the bridge deck.

There are six suspension cables or bridles, each consisting of a rectangular arrangement of elementary cables, as follows :—

Cable 1	3 layers of 4 cables each 84·4mm diameter
Cable 6	4 layers of 4 cables each 84·4mm diameter
Cable 2	4 layers of 3 cables each 68·9mm diameter
Cable 5	3 layers of 3 cables each 68·9mm diameter
Cable 3	4 layers 84·4mm diameter
Cable 4	4 layers 72·5mm diameter

Cables 3 and 4 and the topmost layers of cables 2 and 6 are anchored to the tower, the remaining cables and layers being continuous. The minimum ultimate strength of the elementary wires is 135 kg per square millimetre ; a working factor of safety of 2·5 was employed.

The tower was built with the top curving slightly towards Cologne, tightening of the cables towards the Deutz bank providing the prestressing moments required.

Deck Surface

The bridge surface is laid on aluminium foil and comprises a 23mm-thick lower layer of hot-poured asphalt and a 27mm top layer of the same material. These layers are prevented from slipping by welding to the deck half-round sections of 20mm radius, spaced every 6m at the positions of the joints in the under-layer. For the cycle paths and pavements a double layer of mastic asphalt (2mm by 10mm) is employed.

No longitudinal joints are provided in the surfacing anywhere between the tram rails and the kerb, and cross joints in the top layer only every 18m. The under-layer joints, which, as mentioned, are spaced at distances of 6m, are offset in relation to the top joints. Gaps are conically about 10mm wide at the top and 8mm at the bottom.

For the tramway tracks, a block rail 55mm high is employed, the material being steel "St70" or "St80." The rail was welded in the workshops to a 10mm thick intermediate plate of steel "St52," under 150 deg. Cent. preheat. Where differences in level between the deck and the rail have to be accommodated, this assembly rests on a continuous contact plate welded to the bridge deck and gound flat, the intermediate plate being laterally supported by discontinuous shim plates. Angle irons are welded over the gap to prevent water from seeping in under the rail.

Erection of the Superstructure

On the right bank a 70-tonne derrick crane was used to lift into position the trestle supports and bridge components arriving by barge or by rail. Two auxiliary piers and the permanent pier, No. 5, were used for erecting the 52m span. Two further temporary supports and an auxiliary structure on the river pier (No. 4) were required for the 150m right bank side-span. A special twin-derrick of 140 tonnes capacity was used for this span and subsequently for the 302m-long centre span. The work was carried forward by free cantilever construction to a temporary support set up in the river. This stage can be clearly seen in our first illustration, which also shows the twin-derrick and (on the right) the 70-tonne unloading derrick, as well as the partly erected tower and the portal crane employed in its construction.

Although for the centre span two temporary supports were used, only one of these was in position at any one time, in order not to obstruct shipping. From the right bank the work was carried forward to a point about 210m beyond the tower pier, the overhang being supported in the later stages by the suspension bridles which had meanwhile been placed in position on the completed tower. The first temporary centre support was removed as soon as the short and intermediate support cables had been put in place, and a second support was erected in the river nearer to the left bank. As soon as the long bridles had been placed in position, the closing section (No. 18) was fitted and the second support was also removed.

Starting from No. 2 pier on the Rheinau peninsula, the left bank section of the bridge was constructed, using two temporary intermediate supports. A 55-tonne unloading derrick and a 110-tonne construction twin-derrick were employed ; these were similar in design to the derricks used on the right bank.

The left bank portion of the centre span was advanced in free cantilever construction about 67·5m beyond No. 3 pier, up to and including section 17. The erection derrick was then reversed and the bridge continued towards No. 1 pier and beyond to the abutment.

Approach Structures

The left-bank approach ramp to the Severin Bridge comprises seven continuous prestressed concrete spans resting on reinforced concrete piers, and measures 167·1m from the earth embankment to the abutment of the steel structure. Corresponding with the increase in height above ground level of the roadway, as the bridge is approached, both the height of the piers and the spans increase, the latter from 19·5m over the "Im Sionstal" street to 28·5m at the bridge.

The superstructure consists of two parallel main beams with their axes 16·9m apart, as shown below and on the pull-out plate. These beams are solid and of approximately trapezoidal section, and between them support the webbed central section of the bridge (carriageways and tram-lines), while the cycle paths and pavements are cantilevered on either side. The transverse webs as well as the cantilevered lateral deck slabs are prestressed, while the road deck between the ribs is carried out in plain reinforced concrete. Both the longitudinal and transverse prestressing is according to the system Freyssinet–Wayss and Freytag A.G.

The main beams are supported on single piers arranged in pairs, one for each beam, and spaced 16·4m apart. In plan, the piers have the shape of a foreshortened hexagon (2·2m by 1·4m) with rounded edges, the section tapering about 1 in 10 towards the top. Since the spans and the width are of the same order of magnitude, the support bearings had to be specially designed to allow not only longitudinal displacements—the end of the bridge abutment being fixed—but also lateral movement of one of the two lines of bearings (by providing these bearings with a second set of rollers). It was also necessary to let the bearings rotate freely, both longitudinally and transversely, as otherwise fixing moments would have arisen which would have exceeded the strength of the webs which, for æsthetic reasons, had to be as light as possible. The bearings were therefore given the form of single-point tilting bearings. The piers and abutments were founded on Franki piles.

The design was undertaken by Wayss and Freytag A.G., in collaboration with Professor B. Hermkes, Hamburg, and the work was carried out by a group of firms comprising Hochtief A.G., Strabag-Bau A.G., and Wayss and Freytag A.G., under the overall direction of the last-mentioned firm.

Right Bank Approach

With the exception of the connections at the ends, the ramp structures are continuous, without any joints. The effect of continuity is, however, advantageously reduced by the fixing moments at the piers. Beginning at the bridge, the first span is about 23m long, the second approximately 29m, and thereafter the spans decrease to about 20m.

The superstructure has a constant height of 1·2m ; the ascending and descending parts are respectively 172m and 250m long. The section is a solid beam with wide cantilever slabs extending on either side. Under the descending branch the single row of piers is centrally arranged, while the ascending side of the ramp is slightly eccentrically supported.

The support columns are octagonal, their thickness varying between 2m on the ascending side and 1·5m on the descending side. They are rigidly joined to the superstructure, and rest on the foundations by means of four bearings. This, it is stated, has the advantage that the variation of moments under unequal live loading is reduced. Since the bearings are placed at the bottom of the columns, their maintenance is simplified. These bearings are arranged at the corners of a square, at a distance sufficient to prevent lifting. They are multi-roller bearings and are situated directly on the foundation slab, above ground water level, and inside a concrete trough which prevents earth from getting in. At the fourth row of columns the ramp is fixed, these columns being encastred in the foundation concrete. Universal multi-roller bearings are used in the curve of the descending branch and at the "Altar Mühlenweg" abutment. In the neighbourhood of the bridge abutment the two separate ramp branches come together and are joined by a slab. Partial prestressing, according to the system Dyckerhoff and Widmann, is employed both longitudinally and transversely, using "Sigma 80/105" steel. In the descending ramp the branching-off of the cycle path involved the problem of eccentric loading of the main ramp which was solved by linking on to it a separate cantilever deck plate counterbalanced by a caisson filled with weak concrete.

Left bank approach ramp under construction

Nuclear-Powered Passenger-Cargo Ship "Savannah"

BY OUR AMERICAN EDITOR

No. III—(*Concluded from page 245, September 11*)

The world's first nuclear-powered passenger-cargo ship, the N.S. "Savannah," was launched at the Camden yard of the New York Shipbuilding Corporation in New Jersey by Mrs. Dwight D. Eisenhower on July 21. The 22,000-ton vessel was constructed under a joint contract with the U.S. Maritime Administration and Atomic Energy Commission and will be operated under Government contract by the States Marine Lines. The "Savannah" will be capable of carrying sixty passengers and 9500 tons of cargo at a speed of 21 knots. She will be able to operate for more than three years on the initial 52,000 MWD (megawatt-day) fuel loading of her pressurised water reactor. Her trials are scheduled for the spring of next year.

Auxiliary Reactor Systems

A BUFFER seal system supplies high-pressure purified water to the control rod drive buffer seals, thereby preventing outward leakage of the primary coolant. It will also inject purified make-up water into the primary system when needed. Water for the control rod buffer seals will be obtained from the purification system. There are three charge pumps which will supply water to the seals. Only one pump will operate under normal conditions when the leaks are new. Two pumps will operate toward the end of seal life when flow through the seals increases. The standby pump starts automatically in the event of a pump failure or increased flow requirements. This system also provides additional make-up water to the primary system when necessary. The make-up flow is controlled by the level indication from the pressuriser. The buffer charge pumps, the booster pumps, the coolers and the control valves will be situated outside the secondary shield and will be accessible for maintenance.

A primary purification system removes impurities from the primary cooling water, consisting of dissolved and undissolved corrosion products, fuel and fission products from defective fuel rods and residual impurities in the make-up water. The system is low pressure, and consists of two let-down coolers, two pressure reducing valves, three demineralisers and two filters. During the reactor operation, approximately 20 gallons per minute of the primary coolant is drawn from the system, cooled in the let-down coolers and depressurised by the reducing valves to 110 deg. Fah. and 50 lb per square inch gauge; following pressure and temperature reduction the water is purified by the demineralisers and filters outside of the containment vessel. The three demineralisers have an estimated life of fifty days each. They will be used in sequence so as to allow the plant to operate 150 days before demineraliser replacement is required. Normally the purified water will be returned to the primary loop by the buffer seal system. However, a direct-charging line, with a regulating valve capable of passing a maximum of 60 gallons per minute is also provided. This will permit a high rate of purification to continue even after reactor shutdown, if necessary.

A hydrogen addition system maintains a minimum concentration of 20 cc per litre of dissolved hydrogen in the primary loop to scavenge oxygen liberated by the irradiation of water in the core.

A component waste and drain collection system collects all drainage that might be radioactive. This drainage may occur during initial fill and testing, normal shutdown, decontamination and emergency shutdown. Provisions have also been made to collect the floor drainage from the area inside the secondary shield in drain wells. The system includes two pumps, a containment drain tank, four waste storage tanks, a laboratory waste tank and the associated valves and piping. There are provisions so that the waste in any tank can be sampled. After sampling, the contents of the tank may be pumped to either the aboard-ship stowage tanks or to dock facilities. Although the "Savannah" will be equipped with overboard seachests for dumping the contents from the waste tanks at sea, this procedure will not be used until such time as an international agreement has been reached regarding the permissible level of radioactivity that may be discharged at sea. Normally, the waste collected in the drain system will be of very low radioactivity.

The gaseous adsorption and waste collection system has two functions. First, it will collect the majority of the radioactive gases that could be released should a fuel cladding defect develop. Secondly, it will provide for the dilution of some gaseous activity in conjunction with filtration and release to the atmosphere at tolerable levels. The adsorption equipment operates on the vent gas from a stripping column situated on the buffer seal surge tank. The gas is purified by combining any oxygen present with part of the hydrogen flow and by adsorbing the fission product gases on charcoal maintained at a reduced temperature. Any uncondensable gases that are vented from the various systems are collected in a common manifold. The manifold gases will be discharged into the containment vessel or under proper environmental conditions to the stack at a point upstream of the filters. A radiation monitor on the discharge side of the manifold will provide an alarm if the activity released exceeds preset levels. Following the alarm the vents may be selectively closed to isolate the offending source and allow for some delay before release. The secondary shield area will be continuously ventilated to prevent accumulation of activity. The containment will be purged prior to entry to dilute and remove possible accumulations of radioactivity.

The sampling system has three functions. First, it supplies representative liquid samples to indicate the effectiveness of the primary purification system. Secondly, it supplies liquid samples of the drains collected in the laboratory waste tank, the high-activity waste storage tanks and the inner bottom tanks. Finally, it supplies a continuous flow of primary water to a fission product monitor and purified water to a radiation monitor.

A primary relief system prevents the pressure at any point in the nuclear portion of the plant from exceeding that for which it was designed and collects and condenses effluent that may be radioactive. The effluent from all relief valves that vent potentially radioactive fluids is passed into the effluent condensing tank. This tank contains water which condenses the vapour. The uncondensable gas is handled by the gaseous waste and drain collection system. Since the heat and storage capacity of the effluent condensing tank may be exceeded in an extreme emergency, the tank is equipped with its own relief valve. The discharge from this valve will pass directly into the containment vessel.

The intermediate cooling system provides fresh water at 95 deg. Fah. to cool such components as the primary circulating pumps, the primary shield tank, the containment air-conditioning unit, the let-down coolers and the gaseous waste collection system. It also provides an intermediate barrier between the primary system coolant and the sea water used in turn to cool the fresh water of the intermediate system. The system consists of two heat exchangers, two fresh water pumps, a surge tank and the appropriate piping and valves. The fresh water removes the heat from the primary component and gives it up to the salt water through one of the two heat exchangers. The salt water is then returned to the sea. It picks up no radioactivity during the heat exchange.

The emergency cooling system removes decay heat from the core when all electrical power supplies—except the 300kW diesel generator—are inoperative due to an accident, such as collision, fire or flooding of the machinery space. This heat extraction is accomplished by passing a portion of the primary coolant through a heat exchanger and then pumping it back into the primary system. The heat is removed from the heat exchanger by salt water, which is returned in a non-radioactive condition to the sea. Salt water in this system is also used as an emergency supply to the cooling coils in the containment cooling system and serves to cool the emergency canned pump.

The radiation monitoring system determines the amount of radiation at selected points throughout the ship and gives an alarm if the level becomes dangerous at any point. The system is designed to provide adequate protection for personnel and equipment associated with a nuclear-powered commercial merchant ship, yet afford the flexibility that may be required for future technical investigations. There are thirty-two monitoring points. Twelve of these points are monitored constantly, the remainder being scanned either automatically or manually as the operating conditions dictate.

The entire system is divided into the following general categories :—

(*a*) *Fixed Health Physics Monitoring.*—There are three channels that make up this portion of the system. Channels No. 1 and No. 2 each handle six area detectors. These detectors monitor the environmental radiation level in the selected locations. In addition to indicating the radiation level, the monitoring panel provides a recording facility to maintain a permanent record. Channel No. 3 covers three access detectors, which determine the background level at points of entry into the containment or demineraliser compartment. These detectors indicate whether or not the compartment may be entered after reactor shutdown.

(*b*) *Plant Functional Monitoring.*—This portion consists of five channels. Channel No. 4 consists of five detectors that detect any leakage of radioactive water from the primary system to the intermediate cooling water system. Channels No. 5 and No. 6 with one detector each, detect radioactive leakage into the secondary system. Channel No. 7, with one detector, detects the presence of fission products in the primary coolant due to fuel element failures. Channel No. 8 detects radioactive material passing through the ion-exchangers which indicates that the exchange resin is depleted and must be renewed.

(*c*) *Waste Disposal Monitoring.*—This portion consists of eight channels ; each channel has one detector. Channels No. 9, No. 11, No. 13, and No. 15 will detect radioactive particles and Channels No. 10, No. 12, No. 14, and No. 16 will detect radioactive gas in the stack gas.

(*d*) *Portable Equipment.*—The ship carries a complete set of portable equipment for measuring various forms of radioactivity throughout the ship.

(*e*) *Film Tags.*—There are over 400 locations throughout the ship where film tags are installed to keep a cumulative record of radiation.

Reactor Safety System

The reactor safety system monitors signals from the nuclear and non-nuclear instrumentation to detect unsafe conditions and initiates corrective action as necessary. Two modes of corrective action, scram and fast insertion, are initiated by the safety system depending upon

the nature of the abnormal condition. During scram, all withdrawn control rods are rapidly inserted into the reactor core by hydraulic pressure. During a fast insertion, all withdrawn control rods are rapidly inserted at the maximum rate available through the electromechanical drive.

The reactor safety system is designed to protect the reactor from damage during abnormal conditions except a major rupture in the primary system. The number of scram signals has been kept to a minimum consistent with the philosophy of reactor protection. To minimise spurious scrams, coincidence of unsafe indications from two independent instruments is utilised wherever possible. The signals which initiate a scram during power operation of the reactor are: (1) neutron flux greater than 130 per cent maximum power; (2) primary coolant temperature greater than 540 deg. Fah; (3) primary system pressure less than 1200 lb per square inch; (4) loss of power to all four primary coolant pumps; (5) low hydraulic supply manifold pressure; (6) reactor period less than three seconds; and (7) operator action.

Electrical Plant

As most of the reactor auxiliaries and other vital auxiliaries are electrically driven, the electrical generating plant of the "Savannah" is extensive. The electric generating equipment consists of two 1500kW turbo-generators, two 750kW auxiliary diesel generators and a 300kW emergency diesel generator. The 300kW emergency diesel generator is situated on the navigation bridge deck and will supply power to the emergency switchboards when the main turbo-generators and auxiliary diesel generators are inoperable. The turbine and auxiliary diesel generators, which are situated in the machinery space, will supply power to the main switchboard. The main generators consist of two 1500kW turbo-generators situated in the machinery space, are rated at 450V, three-phase, 60 c/s, and are capable of delivering a 25 per cent overload for two hours. The operation of the main generators is possible during periods of nuclear reactor operation and for a few minutes after reactor shutdown. During normal ship operation, power for the electrical system will be supplied by the main generators.

The two 750kW diesel generators situated in the machinery space are provided for the following functions: (1) provide power for reactor start-up; (2) provide spare generator capacity for normal operation; (3) provide power to operate loads required for decay heat removal after a "scram" or normal shutdown of the reactor; and (4) provide "take home" power when the nuclear propulsion plant is inoperative.

The main switchboard is divided into two sections and situated in the control console room. One turbo-generator and one diesel generator are connected to each section of the main switchboard and the two sections are connected by a normally-closed circuit breaker. The primary function of the main switchboard is to control the generating equipment and distribute electrical power to all electrical equipment on the ship. The emergency switchboard is situated on the navigating bridge deck where it can be used to control the emergency generating equipment and to supply power for vital loads during periods of emergency, either from the main switchboard or the 300kW emergency diesel generator.

During normal operation, power for the electrical system will be supplied by the two 1500kW turbo-generators with the two 750kW diesel generators on standby. The emergency switchboard in turn is normally supplied from the main switchboard by means of bus ties. During this period, occurrence of any one of the following conditions will result in automatic starting of the two diesel generators and automatic tripping of the ship's non-vital loads: (1) overcurrent on either turbo-generators; (2) tripping of either turbo-generator breaker; (3) reactor scram; or (4) reverse power relay indication on either turbo-generator. The standby diesel generators have a ten-second start-up capability and the first unit reaching rated voltage is automatically synchronised with the turbo-generators already in operation. Automatic paralleling of the second diesel generator then follows. The loss of all power from the main switchboard will result in automatic start-up of the emergency diesel generator and the emergency cooling system.

Steam Propulsion System

The steam propulsion machinery space is situated aft of the nuclear space between frames 126 and 148. This space is 55ft long and 78ft wide and extends from the tank top to "C" deck, a distance of 32ft. This space contains all the major machinery required to propel and service the ship. An observation gallery is situated at "C" deck level to permit viewing of the machinery space.

The main components of the engine-room machinery of the "Savannah" were supplied by the De Laval Steam Turbine Company, of Trenton, New Jersey. This equipment consists of the main propulsion turbines, main reduction gears, turbo-generators, main and auxiliary condensers, feed water heaters and pumps and auxiliaries. The main propulsion unit is essentially of the same design as used in normal steam turbine-driven ships. However, the design for the "Savannah" presented unique problems, because of the special conditions surrounding the requirements for a nuclear surface vessel.

In the first instance, the main turbines had to be designed to develop 22,000 s.h.p. using saturated steam ranging in pressures from 430 lb per square inch absolute to over 700 lb per square inch absolute. On the other hand, in the conventional ship's power plant superheated steam is supplied at a given pressure and temperatures, commonly 600 lb per square inch gauge and 850 deg. Fah. This steam has approximately 360 deg. Fah. of superheat when it enters the turbines, but leaving the last stage, it contains about 10 to 12 per cent moisture. In the case of the "Savannah," the steam enters the turbine in a saturated condition, and as it expands in the turbine and does work to drive the ship, the amount of moisture increases rapidly. It was therefore necessary for the builders to remove this water from the turbine in order to prevent the turbine blades erosion. This is not a new problem, and it is somewhat paradoxical that in the most modern surface vessel of our times, the turbine designer must look back some twenty or more years to the days before the use of superheated steam. Obviously, all the refinements in withdrawing the moisture from the turbines now utilised represent the latest advances in this science, but the principles were developed many years ago.

Even the main reduction gear, which was also designed and manufactured by De Laval, presented a special problem, because there was an additional safety requirement that, in the event of loss of reactor power, it must be possible to operate the ship. Therefore, the firm provided a design in which a 750 h.p. electric motor was mounted on the reduction gear. By means of a special clutch and a simple lever, it is possible to engage this so-called "take home" motor to the gear. The power to drive this "take home" motor can come from the turbo-generators if conditions permit, or from an emergency diesel generator.

Conventional turbo-generators to develop the ship's electric power could not be used because of the stringent space requirement. In the "Savannah," the ship's electric power is supplied by two 1500kW De Laval turbo-generator sets, which incorporate a specially designed De Laval–Stoeckicht planetary gear to reduce the speed of the turbine to that required by the generator. The use of the De Laval–Stoeckicht planetary gear facilitated considerable space saving, which was extremely beneficial because of the necessity of having a remote control room. Finally, the condensers also had to be specially designed. It is absolutely necessary in this reactor plant that no salt water be admitted to the steam generator; therefore, the condenser tubes are welded to the tube sheet, instead of the usual method of "packing" the tubes.

The main propulsion unit is a cross-compound turbine, double-reduction gear unit of nearly conventional design developing a normal power of 20,000 s.h.p. at 107 r.p.m., and a maximum continuous duty of 22,000 s.h.p. at 110 r.p.m. The astern power is 8000 s.h.p. at 53·5 r.p.m. which complies with the usual formula of 80 per cent normal ahead torque at 50 per cent of speed with a steam flow not to exceed 100 per cent of the normal ahead flow. The high-pressure turbine consists of nine stages of single-row impulse wheels. The casing is split in the horizontal plane and the bucket wheels are integral with the rotor. At normal power, the

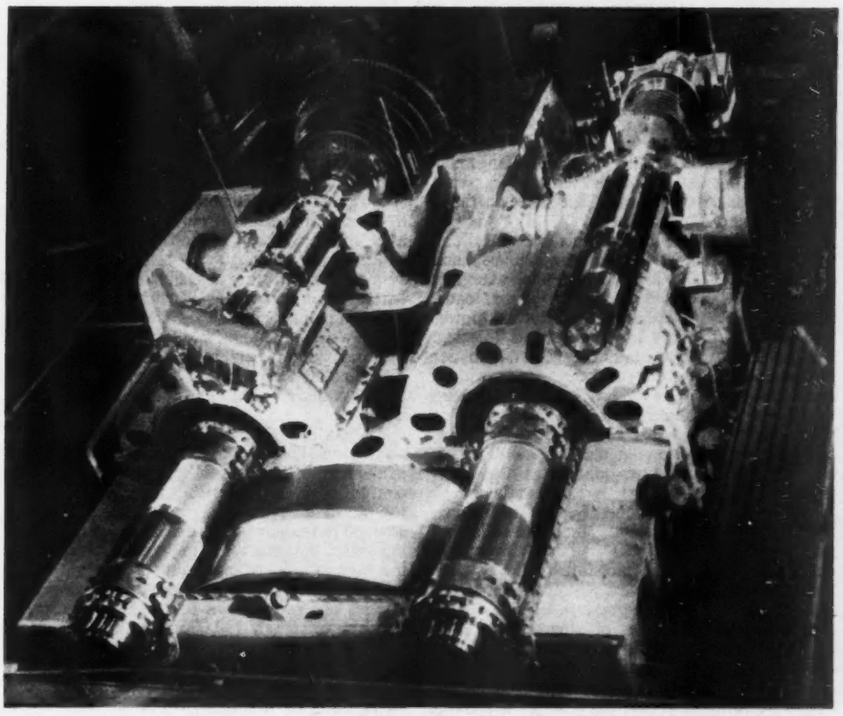


Fig. 14—Shop erection view of the De Laval main steam propulsion unit with high- and low-pressure turbines and reduction gear

high-pressure turbine will operate at approximately 4500 r.p.m.

The low-pressure turbine contains both the ahead and the astern turbine. The ahead turbine consists of seven single rows of impulse type blading. The astern turbine consists of two impulse stages, the first stage being a two-row and the second stage a single-row wheel. The casing is also split in the horizontal plane and the ahead steam inlet and exhaust outlet are in the lower half of the casing, while the astern steam inlet is on top of the exhaust belt with an internal expansion joint. The last two ahead stages and the last astern stage are integral with the rotor, while the other stages are built up. At normal power the low-pressure turbine will operate at about 3000 r.p.m.

The accompanying illustration (Fig. 14) shows a shop view of the main propulsion unit with the covers removed. It will be noted that the main reduction gear is a double helical, double reduction, articulated unit, with the first reduction forward of the second. The low-speed pinions are driven by quill shafts from the high-speed gears. The turning gear is element. Specially designed blades impart a rotating motion to the steam and centrifugal force holds the entrainment at the outer periphery until separation is effected. The dried steam leaves the purifier at the outlet and the moisture forms droplets and is guided to the drains.

After the steam leaves the moisture separator, it is essentially in the saturated condition and then enters the low-pressure turbine. Moisture collecting provisions are included on all but the first stage of the ahead low-pressure turbine. Drain nozzles are fitted to all diaphragms to allow the moisture to go to the drain connection or to the exhaust.

One of the important components of the power plant is the main condenser. It was designed and manufactured by the Ingersoll-Rand Company and is arranged in the ship in such a manner that it is hung from the low-pressure turbine. After full consideration of various alternative methods of tube attachment, a single tube sheet design with welded tubes was selected. The tubes are welded to the tube sheets to ensure positive tightness and then after welding are rolled lightly to add resistance to vibration.

motor, with a special control and a special coupling to engage at the aft end of the high-pressure, high-speed pinion. This coupling was especially designed by De Laval and, by its means, the motor can be engaged very quickly by operating a lever whenever it is desired to operate the "take home" motor, after the turbines have been secured, but not disconnected.

Each of the two 1500kW turbo-generator sets has a driving turbine with eight impulse stages, also designed for steam ranging from 430 lb per square inch absolute to over 700 lb per square inch absolute, dry and saturated. A De Laval-Stoeckicht planetary gear, with an input speed of 5600 r.p.m. and an output speed of 1200 r.p.m., is rigidly connected to the turbine and generator shafts. The use of planetary gears allows considerable space saving, which was important to the engine-room arrangement.

Main Control Room

The main control room is situated in the upper level of the machinery compartment

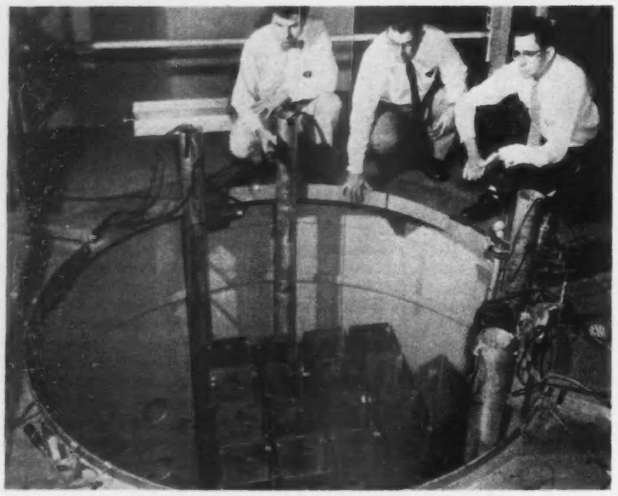


Fig. 15—Reactor core tests being conducted at the critical experiment facility of Babcock and Wilcox

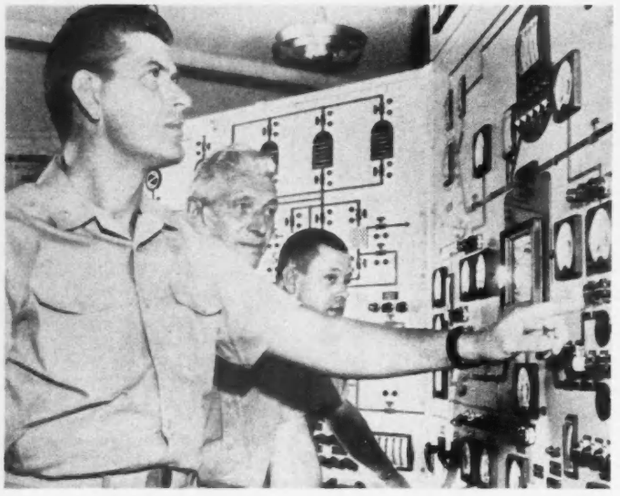


Fig. 16—Trainees operating the full-scale ship's control panel simulator at Lynchburg

situated at the aft end of the low-pressure high-speed pinion. The diameter of the 35-ton bull gear at the pitch circle is approximately 176·6in and the overall ratio on the high-pressure side is 42·3 : 1 and the low-pressure side 28 : 1. The bull gear is located axially by a 45in Kingsbury thrust bearing at the aft end of the gear case with a separate thrust shaft between the main gear shaft and the line shaft.

The steam conditions for this unit can vary from approximately 430 lb per square inch absolute to over 700 lb per square inch absolute, with the higher pressures at the lower loads. The design steam conditions at normal power are 465 lb per square inch gauge and 463 deg. Fah.; at maximum load, they are 445 lb per square inch gauge and 457 deg. Fah., with a condenser vacuum of 28½in Hg. These steam conditions necessitate certain deviations from what might be called a conventional design of a turbine of this size. At the design full power condition, the moisture content at the high-pressure turbine exhaust is approximately 11 to 12 per cent. Consequently, in this turbine, from the sixth stage on, moisture-collecting provisions have been included in the diaphragm design which drain the moisture to the exhaust belt. The steam then enters a moisture separator before entering the low-pressure turbine. This separator has two stages of separation; first, an impingement or baffle separation; secondly, a controlled centrifugal separation. In the impingement or baffle separation wet steam enters a purifier and impinges on a baffle, and most of the entrainment is thrown to the wall where it flows to the drain. In the second stage the remaining wet steam enters a separating

Also provided in the condenser design is a method of isolating the tube end sections, should condensate contamination due to excessive salinity be detected as a result of improper tube-to-tube sheet attachment and tube end failure. Under normal conditions of operation, all the surface is effective. When contamination is indicated by a detecting device, it is possible, by means of the use of close support plates and a collecting well, to isolate the ends of the condenser and, through a contaminated drain system, prevent the contaminated water from entering the feed water system.

The auxiliary condensers are also constructed with welded tube ends and have a contaminated disposal system similar to the main condenser. The auxiliary condensers, however, are of the two-pass design, whereas the main condenser is a single-pass unit with scoop injection for normal operation and a circulating pump for standby and manœuvring. The characteristic operation of the reactor makes another departure from the conventional arrangement necessary, because the steam generation in the reactor cannot be stopped as quickly as one can close the manœuvring valve, without requiring excessive action on the part of the reactor control system. Consequently, two conical, perforated, stainless steel nozzles are provided in the main condenser, so that approximately 190,000 lb per hour of steam at 250 lb per square inch absolute can be dumped into the main condenser without the necessity of using cooling water, and a lesser amount can be dumped by a similar nozzle in each of the auxiliary condensers.

Another deviation from a conventional power plant is the provision for the "take home"

just aft of the propulsion units. This space is responsible for the safe operation of the ship's entire power plant much in the same manner as the pilot house is responsible for the safe navigation of the vessel. Access to this area is by stairways down from "C" deck and doors at both ends leading directly into the engine-room. In addition, the bulkhead common with the engine-room is fitted with large, double-thickness glass windows to permit observation of the main control console from the visitors' gallery and the machinery space. Likewise, the console operators can visually monitor the engine-room situation at all times. This arrangement minimises some of the uneasiness associated with the remote operation of large machinery units without being able to see what is going on.

The operating areas of the control room are air conditioned. The overhead ceiling is of translucent plastics material with illuminated sections. All visible surfaces are finished in distinctive colour combinations. The major components contained in this compartment are: (*a*) central control console and associated auxiliary cubicles; (*b*) main electric power generator and distribution switchboard; (*c*) radiation monitoring cabinets; (*d*) reactor control and safety cabinets; and (*e*) television equipment for monitoring the reactor plant inside of the containment vessel. The main control console is a nerve centre whose primary function is to monitor, display and control all the essential functions pertaining to the ship's nuclear reactor, propulsion system and electrical power plant, including related auxiliary systems.

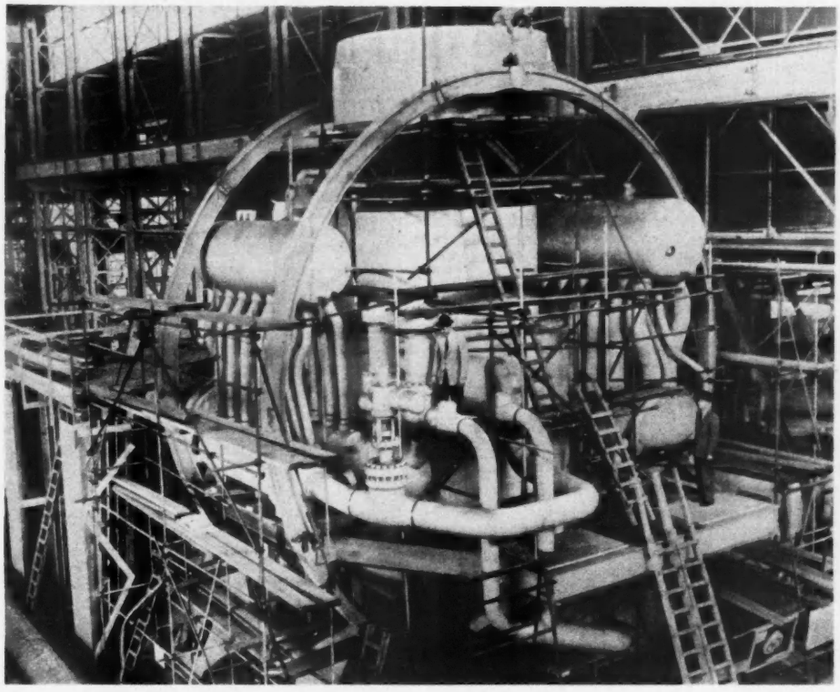


Fig. 17—Full-scale mock-up of the entire primary reactor system erected at the Camden yard of the New York Shipbuilding Corporation

Personnel Training

All the men who will form the ship's complement will be from the States Marine Lines, which will operate the vessel on her initial "Atoms for Peace" cruise and subsequent commercial voyages. However, the roster of the present training classes contains many names representing other marine interests as well as several foreign nations. The responsibility for the nuclear training has been placed in the hands of the Atomic Energy Division of the Babcock and Wilcox Company, the prime contractor for the design and manufacture of the nuclear propulsion plant. The programme was set up co-operatively between the U.S. Maritime Administration, Atomic Energy Commission, States Marine Lines, and the prime contractors. At present there are three classes undergoing training. The first class started on September 29, 1958. The second class began their course on April 14, 1959. The third class, consisting entirely of senior deck officers, started their course on May 4, 1959. From the first two classes the reactor operators and engineering officers will be selected. Class No. 2 is undergoing a slightly shorter course only because every member has an engineering degree. The man who will command the "Savannah" has not been selected yet, but he will probably be one of the senior deck officers in the third class.

The training programme is divided into three phases. Phase I consists of academic study on the campus of Lynchburg College at Lynchburg, Virginia, with some experimental reactor experience at the Critical Experiment Facility (Fig. 15) of Babcock and Wilcox just outside Lynchburg. Phase II takes the students through field training, where they visit and participate in operating reactor installations throughout the United States. This phase broadens their experience with pressurised water reactors and also acquaints them with other kinds of reactor systems. Phase III will take place mostly at the yard of the New York Shipbuilding Corporation, where all nuclear components are being installed. The students will learn every detail of the vessel's construction and participate in the installation of various reactor system components. The students will then conclude their training by taking an active part in the testing and start-up of the reactor propulsion system.

Of the various models used in the training programme, two are of particular interest. One is the simulator (Fig. 16) which consists of a full-scale operating control panel, an electronic instructor's problem board, and an analogue computer that takes the place of the reactor. For example, the students operate the control panel exactly as they will when starting the "Savannah" and bringing her to normal cruising operation. The instructor, by manipulating switches on his problem board, can duplicate any variation or malfunction in the nuclear propulsion system which shows upon the control console. The students must then analyse the situation quickly and take immediate corrective action. All the conditions surrounding a problem are recorded electronically, as are the students' reactions. Any serious malfunction calling for immediate shut-down of the reactor would, of course, result in this action being taken automatically by the safety control circuits. Such a reactor "scram" cannot be stopped by the operators at the control console once it has begun. Each student will receive about sixty hours of instruction and practice on the simulator. In this time he will become familiar with the location and operation of all instruments and controls and will learn to respond swiftly and effectively to changes in operating conditions. To help him in this, a graphic control panel is used. In the graphic system, both colour and equipment silhouettes are used. For example, the instrument that continuously records reactor conditions is mounted within a silhouette that resembles the reactor. Each major component of the system is represented to the operator in a similar manner. These control panel components are connected by coloured plastics strips which represent the piping and circuitry in the actual power plant. Each colour represents a specific part of the system.

Another model worthy of note is the "life-size" mock-up of the entire primary reactor system (Fig. 17), situated at the New York Shipbuilding yard. This model serves not only for instruction, but also was an aid in the fabrication and installation of actual components on board the "Savannah."

Schedule of Tests

All scheduled tests have been divided into two categories: standard marine equipment and systems, and nuclear equipment and systems. The standard marine equipment and systems will be tested by authority of test procedures approved by the U.S. Maritime Administration and other regulatory bodies; these tests will be conducted by the New York Shipbuilding Corporation and witnessed and evaluated by inspectors of various regulatory agencies. The nuclear equipment and systems category has been subdivided into six successive test phases to provide the ultimate in testing and operational safety in conformity with the requirements of the Atomic Energy Commission's Advisory Committee on Reactor Safeguards. The tests included in each phase are a function of the construction status of the various equipment items and systems and are arranged to attain sequential testing and data. All tests of a previous phase must be completed successfully before succeeding phase testing is to be authorised.

Phase I.—Pre-operational integrity testing will be conducted on the power plant components and systems to verify thermal and hydraulic design, perform hydrostatic strength testing, perform system flushing and cleanliness tests, calibrate non-nuclear instrumentation and verify the proper installation and operation of manual and automatic controls.

Phase II.—Pre-critical systems testing is to be conducted to determine the functional reliability of the nuclear power plant before authorisation can be obtained for loading the reactor vessel with the fuel core. During this phase the nuclear plant equipment and systems will be operated at rated pressure and temperature, using a supplementary heat source. Tests will cover such items as: (1) fluid system leak tests; (2) operation of rotating or reciprocating equipment; (3) operation of systems at temperature and pressure to determine integrity and operating characteristics; (4) check of operating procedures (filling, draining, start-up, running, shutdown); and (5) instrumentation check and preliminary calibration at operating temperature, pressure and flow. Upon the successful completion of this phase, including nuclear instrumentation calibration, the fuel core will be loaded into the reactor vessel. Core loading is expected in the spring of 1960.

Phase III.—Initial critical and zero power testing will follow the installation of the fuel core. This phase will include: (1) determination of reactor core data; (2) preliminary calibration of nuclear instrumentation; (3) operational tests of control rod mechanisms; (4) obtaining flow characteristics of primary coolant system; (5) complete testing of reactor safety and control systems; (6) criticality and lower power operation, and (7) checking power plant manual low-power operating procedures. First criticality is expected to be achieved during the late spring of 1960.

Phase IV.—Power operation at dockside, when the entire power plant will be operated under steady state and transient conditions as determined by the maximum horsepower permissible for transmission to the ship's propeller while the ship is secured to the dock. These tests will verify that all equipment, components and systems are capable of safe and reliable sustained operation and will be the basis for the authorisation of sea trials. In addition, this phase of testing will permit the evaluation of maintenance and operating procedures and will provide an opportunity to familiarise the vessel's operating personnel with the propulsion plant.

Phase V.—Sea trials, when the vessel will be taken to sea and subjected to extensive trials and operating tests up to maximum full power to demonstrate reliable operation under seagoing conditions.

Phase VI.—Developmental operation will commence on completion of the sea trials, when the ship will be placed in limited commercial operation, carrying cargo and passengers on a non-scheduled basis. At the same time, as part of the ship's "floating laboratory" function, operating data will be developed and analysed as a guide to the ship's full commercial operation and to the evolution of future nuclear merchant ships. During this phase, which is expected to last about two years, it may be necessary to conduct adjustment and calibration tests similar to those of earlier phases. To broaden operating experience, some components may be replaced as developed or experimental models become available.

Personal and Business

Appointments

MR. E. P. BEESLEY has been appointed director of Euclid Wagon Hirers, Ltd.

SQUARE D, Ltd., has announced the appointment of Mr. R. G. Camp as its sales manager.

WILLIAM BOBY AND CO., Ltd., has appointed Mr. G. S. Solt a chief development chemical engineer.

MR. J. E. ROBSON, of Samuel Osborn and Co., Ltd., has been appointed a director of the company.

SILENTBLOC Ltd., has appointed Mr. F. S. Bryant, 217, Meridan Drive, Birmingham, as its Midland area manager.

EDWIN COOPER AND CO., Ltd., announces that Mr. Philip W. Lake has been appointed secretary and Mr. M. Field, assistant secretary.

MR. T. FURNESS, secretary and a director of Thomas Robinson and Son, Ltd., has been appointed a joint managing director of the company.

MR. R. S. MEDLOCK, A.M.I.E.E., A.M.I.Mech.E., technical and home sales director of George Kent, Ltd., has been elected president of the Society of Instrument Technology.

THE BRITISH PITOMETER COMPANY, Ltd., announces the appointment of the following additional directors, Mr. Alexander Robertson, Dr. P. L. Boucher and Mr. W. J. Robinson, M.I.Mech.E.

MR. JOHN DOLPHIN, engineer-in-chief of the research group of the United Kingdom Atomic Energy Authority, will become joint managing director of Lansing Bagnall, Ltd., Basingstoke, on December 1.

B.T.R. INDUSTRIES, Ltd., has announced that Mr. P. W. Howard has relinquished the office of managing director but will remain a director and the deputy chairman of the company. Dr. W. D. Scott has been appointed to succeed Mr. Howard as managing director.

THE BRITISH INTERNAL COMBUSTION ENGINE MANUFACTURERS' ASSOCIATION has announced the following appointments to the Council : Mr. L. P. Lee has succeeded Mr. A. V. Wilkin as chairman, and Mr. H. Desmond Carter, M.I.Mech.E., has been appointed vice-chairman.

RUSTON AND HORNSBY, Ltd., announces that Mr. H. Riggall, managing director and deputy-chairman, is, at this own request, to relinquish his executive responsibilities as from December 31, but he will remain with the company as a non-executive director and as deputy-chairman, Mr. V. R. Prehn and Mr. G. W. Bone will become joint managing directors on January 1, 1960.

JOHN BROWN AND CO. (CLYDEBANK), Ltd., announces that Sir James M. McNeill will relinquish the managing directorship of the company on September 30, but will remain deputy chairman. He will retain his seat on the board of the parent company, John Brown and Co., Ltd. Mr. John Brown, deputy managing director of John Brown and Co. (Clydebank), Ltd., will be appointed managing director from October 1.

ASSOCIATED ELECTRICAL INDUSTRIES, Ltd., has announced the following divisional management appointments : electronic apparatus division, Mr. E. Alexander, general manager ; Mr. E. T. W. Barnes, manufacturing manager ; Dr. A. L. Whiteley, chief engineer. Motor and control gear division, Mr. J. G. Boddy, general manager ; Mr. A. G. W. Cannon, manufacturing manager ; Mr. A. G. Williamson, chief engineer. Switchgear division, Mr. J. R. Wilkinson, general manager ; Mr. R. Clough, manufacturing manager ; Mr. C. F. Humphreys, chief engineer. Transformer division, Mr. C. P. Holder, general manager ; Mr. A. Jones, manufacturing manager ; Mr. L. C. Richards, chief engineer. Traction division, Mr. F. Whyman, general manager ; Mr. R. P. Knight, manufacturing manager ; Mr. G. R. Higgs, chief engineer.

Business Announcements

MR. CHARLES W. MOLLER, tool room manager at the Ilford factory of the Plessey Company, Ltd., has retired.

FERODO, Ltd., is to open new premises at 3, Condercum Road, Newcastle upon Tyne, 4 (telephone Newcastle upon Tyne 39131/2).

S. H. HANNAH, Ltd., announces that it has moved its works and offices to Queen Street, Redditch, Worcs (telephone Redditch 3655/7).

FREDK. BRABY AND CO., Ltd., 352–364, Euston Road, London, N.W.1, states that Mr. M. E. Chivers, marketing manager, has now left the company's service.

MACKAY INDUSTRIAL EQUIPMENT, Ltd., states that it has appointed Mr. Colin McInnes as chief project engineer of a new solids handling pump division.

BOVING AND CO., Ltd., is to move from 56, Kingsway, London, W.C.2, to Villiers House, 41-47, Strand, London, W.C.2 (telephone Trafalgar 2401-6), on September 21.

THE INTERNATIONAL SYNTHETIC RUBBER COMPANY, Ltd., Hythe, Southampton, states that work has started on a new plant to produce general purpose synthetic rubber latex.

CHARLES COLSTON, Ltd., announces that the head office of the Colston group of companies has moved to 7-11, Lexington Street, London, W.1 (telephone Gerrard 9531).

U.S. INDUSTRIES INC. (GREAT BRITAIN), Ltd., New Bond Street House, 1-5, New Bond Street, London, W.1, has been formed to co-ordinate activities in Europe of U.S. Industries Inc.

ARENCO A.B., of Sweden and ALITE MACHINES, Ltd., of Great Britain, have created a common company, Arenco-Alite, Ltd., Pixmore Avenue, Letchworth, Herts (telephone Letchworth 965).

SHEEPBRIDGE EQUIPMENT, Ltd. (foundry division), and Sheepbridge Alloy Castings, Ltd., announce the appointment of a new Lancashire area sales representative, Mr. J. E. Pearson, " Whitecroft," Whinney Lane, Langho, near Blackburn.

MR. RANDOLPH W. LADBROOKE has resigned his directorship of David Brown Construction Equipment, Ltd., in order to devote his full time to Arthur Bray, Ltd., and Marine Power (Poole), Ltd., of which companies he is managing director.

PEARSON PANKE, Ltd., 1–3, Hale Grove Gardens, London, N.W.7, announces that L. Schuler A.G., Goeppingen/Wuertt, and S.M.G.-Sueddeutsche Maschinenbau-Gesellschaft M.B.H., Wiesental/Baden, have decided to pool their interests for the purpose of co-ordinating production programmes. Pearson Panke, Ltd., who has represented the two companies for many years, has now become representative of the associated companies.

DAVID BROWN CONSTRUCTION EQUIPMENT, Ltd., has moved its home and export sales departments from Hanworth Park, Feltham, Middlesex, to the main David Brown tractor factory at Meltham Mills, near Huddersfield. The Northern parts and service depot of the company has been transferred from Moll Springs, Netherton, near Huddersfield to the principal David Brown parts and service factory, Scarr Bottom, near Huddersfield.

THE MOND NICKEL COMPANY, Ltd., announces that the development branch of the development and research department has been reorganised into four divisions under the general managership of Mr. F. Dickinson. The divisions are as follows : ferrous division, manager, Mr. W. W. Brandwood ; non-ferrous division, manager, Mr. J. Hinde ; applicational engineering division, manager, Dr. A. B. Everest ; general division (including plating, chemical products and nuclear power), manager, Dr. E. C. Rhodes. Mr. L. W. Johnson, assistant manager of the department, having reached retirement age, will relinquish his appointment at the end of September.

Contracts

THE FROMSON CONSTRUCTION COMPANY OF CANADA, Byfleet, Surrey, has been awarded a contract for a new factory and office building for the Educational Supply Association, Ltd., at Harlow. This building is a standard 160ft clear span Fromson arch building of 50,000 square feet area, with single-storey offices. The value of this contract is £90,000.

RICHARD COSTAIN, Ltd., and Dredge and Reclaim, Ltd. (the U.K. subsidiary of D. Blankevoort and Zoon N.V.), have obtained a dredging contract, valued at £1,500,000, at the Port of Guayaquil. The work will be carried out for Compania Raymond S.A., who are members of the Raymond Group and who are responsible for the overall port development. It will involve the moving of some 14,000,000 cubic yards of dredged material, most of which will be pumped ashore as reclamation.

MARCONI'S WIRELESS TELEGRAPH COMPANY, Ltd., has received an order from Cables and Wireless, Ltd., on behalf of Cable and Wireless (W.I.), Ltd., for the establishment of a quadruple diversity u.h.f. tropospheric scatter link between the West Indies islands of Trinidad and Barbados. Duplicated v.h.f. multichannel links to carry the signals between the tropospheric scatter terminals and the operating centres are also to be installed. The Automatic Telephone and Electric Company, Ltd., is to supply the associated carrier equipment and compandors ; test equipment will be provided by Marconi Instruments, Ltd. The Trinidad scatter site will be some 10 miles from the Cable and Wireless station at Port of Spain and a two-way v.h.f. multi-channel link will connect the two stations. In Barbados the scatter station will be at Mount Misery with again a two-way multichannel v.h.f. link connection to the Cable and Wireless radio receiving station at Carrington. The system will carry six telephone speech channels initially, one of which will be used for telegraphy, embodying three 100-baud f.m./v.f. channels. One f.m./v.f. channel will be in two-channel (50-baud) time-division multiplex. Automatic error correction is to be provided by the incorporation of Marconi " Autoplex " equipment. The system will be capable of enlargement to twelve channels.

THE MARCONI INTERNATIONAL MARINE COMMUNICATION COMPANY, Ltd., has concluded negotiations with the Polish Central Import and Export Office for Ships and Marine Equipment as a result of which an order has been placed with the company for equipment to provide complete radio installations for twenty-four ships to be built in Polish shipyards for delivery to Indonesian owners. Eleven vessels of 900 tons will each have main and emergency transmitters and receivers, automatic keying devices, direction-finders, echometers, and portable transmitter/receivers for lifeboat use. Seven ships of 2300 tons, four of 4300 tons, and two of 10,300 tons will have main transmitters with radio-telephone facilities, emergency transmitters and receivers, automatic keying and alarm devices, direction-finders, echometers and lifeboat sets. The total value of the equipment is over £100,000.

LEONARD FAIRCLOUGH, Ltd., of Adlington, Lancashire, the successful contractor for the £5,250,000 contract for the Thelwall Bridge and its approaches, has accepted the tender of Dorman Long (Bridge and Engineering), Ltd., for the supply and erection of the steel superstructure to the value of over £1,250,000. The bridge will have a total length of 4558ft, which includes an approach viaduct on the Cheshire side of seventeen 110ft spans and three 112ft 6in spans, a three-span high-level bridge over the Manchester Ship Canal with a centre span of 330ft, a viaduct on the Lancashire side of eight 109ft spans and two 111ft 6in spans, a three-span bridge over the River Mersey with a centre span of 180ft, and Martinscroft Bridge carrying the diverted road A.57 over the motorway. The bridge over the Manchester Ship Canal is of riveted steel construction, whilst the bridge over the River Mersey and the approach spans are of all-welded steel construction. The total weight of steelwork is approximately 11,250 tons. The bridge will be situated near Warrington and is part of the South Lancashire motorway, extending the Preston by-pass towards Birmingham. The two 36ft carriageways of the motorway are supported for the length of the bridge on eight steel girders spanning between concrete piers 80ft above ground level. The whole of the works are being carried out under the supervision of the Lancashire County Council.

Miscellanea

MURTON COKING PLANT.—In the description of the Murton coking plant which appeared in our issue of September 4 last, it should have been mentioned that the British Reinforced Concrete Engineering Company, Ltd., of Stafford, acted as engineers to the National Coal Board for the whole of the surface structures required in connection with the Murton/Eppleton combined mine. This firm's terms of reference included the earthworks and site preparation for the whole area.

HOT BRASS PRESSINGS AND FORGINGS.—A new publication of the Copper Development Association deals with the production of brass and copper-base alloy components by hot pressing and forging. It describes the methods of production and gives details of the relevant material properties, the presses and tools employed and some useful hints on design. This publication is obtainable free upon application to the Association offices, 55, South Audley Street, London, W.1.

CORRECTION.—In connection with the meetings in Birmingham and Coalbrookdale from September 23 to 25 to commemorate the 250th anniversary of the successful use of coke in ironmaking (see our August 28 issue, page 157), we are asked to make it clear that the British Cast Iron Research Organisation is only one of the bodies supporting the occasion. The event has been organised by a national committee, under the chairmanship of Sir Frederick Scopes, representing the iron and steel industry and many associated industrial and academic interests.

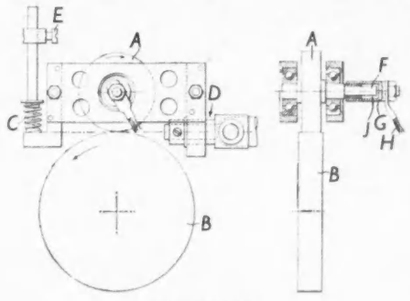
British Patent Specifications

When an invention is communicated from abroad the name and address of the communicator are printed in italics. When an abridgment is not illustrated the specification is without drawings, unless otherwise stated. The date first given is the date of application; the second date, at the end of the abridgment, is the date of publication of the complete specification. Copies of specifications may be obtained at the Patent Office Sales Branch, 15, Southampton Buildings, Chancery Lane, W.C.2, 3s. 6d. each.

ELECTRICAL ENGINEERING

814,828. July 4, 1957.—ELECTRICAL CONNECTION BETWEEN RELATIVELY MOVABLE PARTS, Associated Electrical Industries, Ltd., Crown House, Aldwych, London, W.C.2. (*Inventors: Wallace Hirst and Harold Frederick Kenyon.*)

This invention relates to the provision of electrical connection between relatively movable parts and has an important but non-exclusive application to the transfer of current from or to a rotary current collector, such as a slip-ring, commutator or the like. Referring to the drawings, a cylindrical contact



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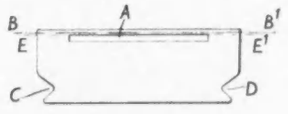
roller *A* bears against the periphery of a rotary current collector *B* and is driven thereby about an axis parallel to that of the collector. Current is then able to flow between the collector and roller through the rolling contact which they make with one another. The roller is maintained in engagement with the collector under suitable pressure by means of a spring *C* acting on the lever framework *D*. A locking screw *E* permits adjustment of the position of the rod to vary the pressure exerted by the spring. The roller is fast with a coaxial spindle *F* in electrical connection with its contact surface. The spindle projects into the open end of a coaxial cylindrical cup *G* to which an external lead *H* is attached. The spindle terminates short of the closed end of the cup and is also spaced from the inner periphery of the latter, thereby defining a chamber *J* which in use is occupied by mercury. In use, the arrangement provides electrical connection between the collector and the external lead by way of the roller, the coaxial spindle, the mercury (not shown) in the chamber, and the cylindrical cup. An alternative arrangement of the mercury chamber and methods of applying this form of collection to a commutator are among other aspects illustrated in the specification.—*June* 10, 1959.

814,679. October 4, 1957.—ELECTRICAL COMMUTATOR CONSTRUCTION, The British Thomson-Houston Company, Ltd., Crown House, Aldwych, London, W.C.2. (*Inventor: Albert John Langham Harvey.*)

According to the present invention the strips between the commutator segments are insulating spacers with narrow longitudinal slots adjacent their outer edges. The spacer shown in the drawing comprises a flat sheet of mica in which a rectangular



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slot *A* is punched. In forming the commutator, the slot in each spacer is arranged parallel and adjacent to the radially outer surface of the commutator and within said outer surface. The outer edges of the spacers are flush or substantially flush with the radially outer surface of the segments. The assembly is then roughly machined into circular form the material of the spacers being removed to the line *B-B*¹. The segments are thus supported during the rough machining by the insulating spacers and so burring of the outer edges of the segments is prevented. The assembled commutator segments are now mounted in the clamping means which form part of the final commutator structure. In the case illustrated the clamping means include two rings of V-shape cross-section clamped together so as to locate the segments by means of V-shaped notches provided in the segments similar to those shown at *C* and *D* for the spacers. The commutator is now lightly machined to ensure concentricity with its clamping means and by this process the material of the insulating spacer is removed until the line *E-E*¹ of the outer edge of the slot is reached. The slot being closed at each end, the insulation extends to the outer periphery of the commutator at both ends after the machining so that there are no gaps into which solder can run when connection is made to the risers (not shown) provided at one end of the commutator. Other slot arrangements illustrated in the specification are for commutators with two brush tracks or those in which the insulation extends to the periphery only at one end of the commutator.—*June* 10, 1959.

EXTRUSION OF METALS

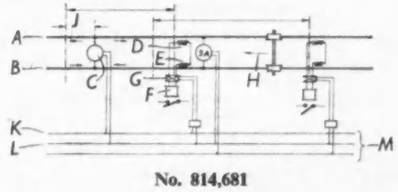
814,558. August 16, 1957.—MOULDED GLASS LUBRICANT FOR USE IN THE EXTRUSION OF METALS, Imperial Chemical Industries, Ltd., Imperial Chemical House, Millbank, London, S.W.1. (*Inventor: Samuel Spenceley Smith.*)

According to this invention, a method for producing a moulded glass lubricant suitable for use in the extrusion of metals comprises compacting a mixture of powdered glass and a solution of sodium silicate to the required shape by a light pressure, and then passing carbon dioxide through the mixture. By following this process, hardening of the moulded mass is quickly obtained since the effect of the carbon dioxide is to cause silica to separate out from the sodium silicate solution in the form of a "gel," and thus the production of the moulded glass is considerably speeded up without the use of high compacting pressures. Conveniently, the powdered glass is of a narrow sieve cut, for example −50+100 B.S.S. mesh, and is mixed with sodium silicate solution having a density of 112 deg. Twaddell, and a viscosity of 9 poises at 20 deg. Cent. The solids content is 45·6 per cent and the molecular ratio SiO_2 : Na_2O is 2·05. The mixture of sodium silicate solution is from 5-10 cubic centimetres of liquid to each 100 grammes of solid. Carbon dioxide gas is passed through the mixture for about one minute, the flow rate being 2 litres per minute for 50 cubic centimetres of material. The extrusion lubricant produced then has adequate strength for handling and for manipulation. If desired, a higher strength can be obtained by adding fine glass powder which will fill the interstices of the moulded product.—*June* 10, 1959.

RAILWAY SIGNALLING

814,681. October 19, 1956.—RAILWAY SIGNALLING TRACK CIRCUITS, Forges et Ateliers de Constructions Electriques de Jeumont, 5, Place de Rio de Janeiro, Paris, France.

The present invention has for its main object to provide track circuit systems for railway signalling with the sections independent of one another, but not insulated electrically, so that the conventional insulating joints are no longer necessary. The



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drawing shows two rails *A* and *B*, without interruptions, the rails being of indefinite length. At any convenient point of the track, there is connected to them a generator *C* providing periodic signalling currents which may be unidirectional or alternating. At a desired distance from the generator there are arranged near the rails pick-up devices *D* and *E* which may be electromagnetic, being, for example, analogous with the secondary windings of current transformers. The pick-up devices feed track relay *F* by the intermediary of a receiver *G* which acts as an energy accumulator. This maintains in the relay a mean current sufficient for the contacts to remain closed, in spite of the periodic character of the signalling current. When an axle *H* of the vehicle, travelling in the direction of the arrow, passes beyond the position of pick-up devices *D* and *E*, the latter are put out of action, for the currents, short-circuited by this axle, no longer circulate beyond the latter; it follows that the track relay is no longer energised. When the axle passes slightly beyond the position of the generator *C*, relay *F* remains de-energised by the short-circuiting of the generator, but when this distance becomes greater, the effect of this short-circuit is attenuated by the impedance of the rails; when the axle reaches a certain distance *J* from the generator, the relay is attracted once more. The operation therefore is just as if the track comprised insulating joints. In order that the signalling currents operating in one block-section shall be able to act only upon the track relays of the same section, the periodic currents emitted by the generators are synchronised with the short durations of intermittent receptivity of the corresponding receiving devices and track relays. For this purpose, the operation of generator *C* and receiver *G* may be determined, for example, by the frequency and phase of a control voltage furnished by the conductors *K* and *L* of a polyphase line *M* which runs alongside the track.—*June* 10, 1959.

GAS TURBINES

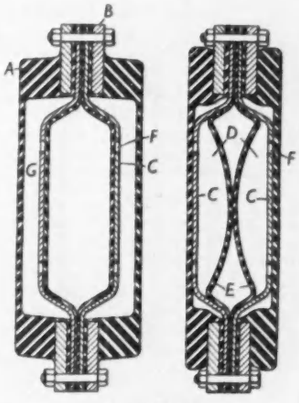
816,553. May 23, 1957.—FUEL CONTROL MEANS FOR GAS TURBINES, Joseph Lucas (Industries), Ltd., Great King Street, Birmingham, 19. (*Inventor: Eugene Harold Warne.*)

It is usual to combine with a gas turbine an air compressor driven by the turbine for supplying air to the combustion chamber of the turbine. For some purposes the capacity of the compressor is made such that it can also supply motive air occasionally to other apparatus. The requirement then arises of providing means whereby the ratio of air to fuel required in the combustion chamber of the turbine can be automatically varied when the compressor is supplying air for a secondary purpose, and the object of the present invention is to enable this requirement to be met in a simple manner. It comprises the combination of a pair of interconnected valves for controlling respectively a secondary air supply and a passage leading to the outer atmosphere from the compressor. Means responsive to the pressure in the passage regulate the rate of supply of fuel delivered to the combustion chamber.—*July* 15, 1959.

SPRINGS

814,748. April 8, 1957.—SHOCK ABSORBERS AND SPRING SUSPENSIONS, George Spencer Moulton and Co., Ltd., Manvers House, Bradford-on-Avon, Wiltshire. (*Inventor: Alexander Eric Moulton.*)

The invention is described with reference to the accompanying drawings showing an improved rubber hydraulic spring, free and under compression. Dished circular rubber springs *A* are bonded to encircling rings *B* apertured to pass bolts and provide a chamber *G* for hydraulic fluid. Complementary dished metal plates *C* are also clamped together by the rings and bolts to provide a secondary chamber *D* which in turn contains a gas bag. This bag consists of a flexible wall or lining *E* filled with air, nitrogen or other inert gas, which may be under initial compression. Ports or orifices *F* in the metal



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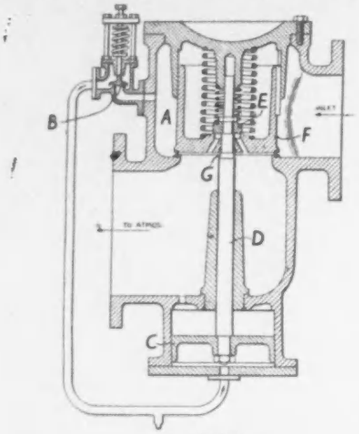
plates effect communication between primary chamber *G* and secondary chamber *D*. Under compression the rubber springs *A* deflect laterally, decreasing the volume of chamber *G* thereby compressing the hydraulic medium and forcing it through the ports *F* into the secondary chamber *D*. The influx of fluid causes a deflection in the flexible lining consequently raising the compression of the gas contained therein. Upon release of the compression the energy stored by the gas is released and the hydraulic medium is forced back through the ports into the primary chamber to restore the state of equilibrium.—*June* 10, 1959.

VALVES

816,390. October 31, 1955.—PRESSURE RELIEF VALVES, British Thomson-Houston Company, Ltd., Crown House, Aldwych, London, W.C.2. (*Inventor : Reginald George Whitehouse.*)

This invention is concerned with pressure relief valves, more particularly valves used in back-pressure and extraction type steam turbines of large capacity. The construction and arrangement is such that at a predetermined pressure a primary relief valve is raised and steam passes through it to a servo-cylinder to displace the servo-piston and its operating spindle, the spindle first raising the pilot valve to relieve the pressure on the main relief valve and thereafter raising the main relief valve from its seating. A preferred construction of the valve is



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illustrated. In operation, when the steam pressure in the steam chamber *A* exceeds a predetermined value, the primary relief valve *B* opens, admitting steam under pressure to the underside of the servo-piston *C*, which moves up with the spindle *D* to open the pilot valve *E* and thereby reduce the pressure on the top of the main valve *F*. The main valve is then opened quickly by the force on the servo-piston acting through the shoulder *G*. When the steam chamber pressure has been released to a predetermined safe value, the valves *F*, *E*, drop back on to their seatings quickly under the combined influence of the springs and steam pressure. The main and pilot valve springs are designed so as to bias the valves to closed position for starting under vacuum conditions which might otherwise tend to draw the valves from their seatings. These springs can be arranged, if desired, to produce a specific pressure gradient for the valve.—*July* 15, 1959.

British Standards Institution

All British Standard Specifications can be obtained from the Sales Department of the Institution at 2, Park Street, London, W.1.

MAGNESIUM AND MAGNESIUM ALLOY INGOTS AND CASTINGS FOR GENERAL ENGINEERING PURPOSES

No. 2970 : 1959. Price 8s. 6d. This new publication supersedes the earlier series of standards for magnesium alloy ingots and castings—B.S. 1272–1280. The requirements of the earlier standards have been amended in the light of more recent experience in magnesium alloys. Specifications for pure magnesium ingots, and for five new alloys in various conditions, have been added. The new specification has been modelled on B.S. 1490 (" Aluminium Alloy ingots and Castings ") in that general requirements are grouped in Sections 1 and 2 for ingots and castings respectively, and specific requirements for each material are included in separate sections. Alloy numbers have been allocated to each material prefixed by the letters " MAG " and symbols are used to indicate form and condition, as in B.S. 1490.

INSULATING OIL FOR TRANSFORMERS AND SWITCHGEAR

No. 148 : 1959. Price 8s. 6d. This revised edition of B.S. 148 applies to unused insulating oil, as delivered in tank wagons or drums, suitable for the immersion or filling of transformers, switchgear and certain other electrical equipment in which oil is required as an insulant or for heat transfer. It does not apply to high viscosity oils, to oils required for cables or capacitors, or to oils for special impregnation purposes. Since the 1933 edition and until the 1951 revision this British Standard dealt with six grades of oil (A.0, A.10, A.30, B.0, B.10, B.30), differing in allowable sludge test limits (letter designation) and in required cold test temperatures (number designation). It was found that all requirements could be satisfactorily met by a single grade of oil, even if the sludge limit were at the higher value permissible for the B grades, provided that oils having a tendency to high acidity development on oxidation were excluded. A limitation on the acidity development permissible in the oxidation test was therefore included in the 1951 revision which also standardised on a single maximum pour point of −25 deg. Fah. (−31·7 deg. Cent.). Minor technical changes in the present revision, compared with the 1951 edition (as amended) are : deletion of the evaporative loss test, which, in view of the adequate limitation of volatility ensured by the specified flash-point, was found to be superfluous ; and the improvement of the procedures for acidity determination by the substitution of alcoholic alkali for aqueous alkali.

A new appendix has been introduced giving the characteristics of the thermometers used in the various tests. Other alterations are mainly of an editorial character. This British Standard is based on information supplied by the British Electrical and Allied Industries Research Association.

METHODS OF TESTING REFRACTORY MATERIALS : ADDENDUM No. 2 : ADDITIONAL METHODS

No. 1902 : 1952. Price 3s. This nine-page addendum to B.S. 1902 : 1952 specifies an alternative method for the determination of silica in alumino-silicate and silica refractories. Other methods in the new publication deal with the measurement of : size of refractory bricks and shapes, bulk density and warpage. The method for the determination of silica is particularly applicable when the determination of other constituents is not required. The addendum contains a full-page diagram of an apparatus for the measurement of warpage.

MECHANICAL TESTING OF STEEL AT ELEVATED TEMPERATURES. PART 1 : DETERMINATION OF PROOF STRESS

No. 3082 : 1959. Price 3s. This new publication forms Part 1 in a series of standards which will deal with the mechanical testing of steel at elevated temperatures. It is based on the work undertaken by Technical Committee 17 (Steel) of the International Organization for Standardization as has been tentatively approved by all the member countries represented by that Committee. It is hoped that the series will help to facilitate the comparison of different steels at elevated temperatures and to unify the methods by which the data are obtained.

In this part, definitions for gauge length, stress and proof stress are followed by requirements for the test piece. Consideration is given to the limits within which the heating apparatus must operate and to the method for measuring the temperature. Other requirements deal with the determination of elongation and with the rate of testing.

Forthcoming Engagements

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of their insertion, the necessary information should reach this office not later than a fortnight before the meeting. In all cases the TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

ASSOCIATION OF PUBLIC LIGHTING ENGINEERS

To-day, Sept. 18.—Music Hall, Union Street, Aberdeen, Annual Conference.

ASSOCIATION OF SUPERVISING ELECTRICAL ENGINEERS

To-day, Sept. 18.—STOKE AND CREWE BRANCH : Royal Hotel, Crewe, " Floor Warming and Infra-Red Heating," C. J. Wheeler, 7.30 p.m.

Mon., Sept. 21.—BOURNEMOUTH BRANCH : Grand Hotel, Firvale Road, Bournemouth, " Wiring Cables," M. P. M. Rowe, 8 p.m.

Tues., Sept. 22.—NEWCASTLE UPON TYNE AND DISTRICT BRANCH : Crown Hotel, Clayton Street, Newcastle upon Tyne, " Magnetic Amplifiers," G. L. Horrobin, 7.30 p.m. ★ OXFORD AND DISTRICTS BRANCH : Employment Exchange, Oxford, " Electrical Safety in the Home," S. J. Emerson, 8 p.m.

Thurs., Sept. 24.—BRIGHTON, HOVE AND DISTRICT BRANCH : New Imperial Hotel, First Avenue, Hove, " The I.E.E. Regulations for the Electrical Equipment of Buildings," S. J. Emerson, 7.30 p.m. ★ SOUTHAMPTON BRANCH : Polygon Hotel, Southampton, " Nuclear and Electrical Space Propulsion Systems," P. A. E. Stewart, 8 p.m. ★ SOUTH LONDON BRANCH : Greyhound Hotel, High Street, Croydon, Surrey, Film, " Power Under Control," 8 p.m. ★ LIVERPOOL AND DISTRICT BRANCH : Visit to Eric Bemrose, Long Lane, Liverpool, 7.30 p.m.

Mon., Sept. 28.—N.W. LONDON BRANCH : Compass Hotel, Watford, " Composition of the A.S.E.E.," W. J. Wheeler, 8.15 p.m.

BRITISH INSTITUTE OF MANAGEMENT

Mon., Sept. 21.—Recital Room, Royal Festival Hall, London, One-day Conference on " Knowing Your Customer," 9.30 a.m.

BRITISH INSTITUTION OF RADIO ENGINEERS

Wed., Sept. 30.—LONDON BRANCH : London School of Hygiene and Tropical Medicine, Keppel Street, Gower Street, London, W.C.1, " Modern Microwave Valves : A Survey of Evolution, Principles of Operation and Basic Characteristics," W. E. Willshaw, 6.30 p.m. ★ TREFOREST BRANCH : Glamorgan College of Technology, Treforest, Glam, " The Use of Demonstration Equipment in Basic Radio Theory " H. Henderson, 6.30 p.m.

INDUSTRIAL WELFARE SOCIETY

Mon., Sept. 28.—Robert Hyde House, 48, Bryanston Square, London, W.1, " Changes in Industrial Law—the New Factories Act Explained," H. Samuels, 2.30 p.m.

INSTITUTE OF BRITISH FOUNDRYMEN

Wed., Sept. 23.—Constitutional Club, Northumberland Avenue, London, W.C.2, First Meeting of the 1959/60 Session, 7 p.m.

INSTITUTE OF MARINE ENGINEERS

Mon., Oct. 5.—STUDENT LECTURE : The Memorial Building, 76, Mark Lane, London, E.C.3, " Watchkeeping and Maintenance in a Motor Ship," S. Speed, 6.30 p.m.

INSTITUTE OF PHYSICS

To-day, Sept. 18.—STRESS ANALYSIS GROUP : The University, Birmingham, Annual Residential Conference.

INSTITUTION OF CHEMICAL ENGINEERS

Tues., Oct. 6.—Geological Society, Burlington House, Piccadilly, London, W.1, " The Controlled Crystallisation of Sodium Chloride," J. Bain and F. Rumford, 5.30 p.m.

INSTITUTION OF ENGINEERING DESIGNERS

Wed., Sept. 23.—YORKSHIRE BRANCH : Midland Hotel, Bradford, Yorks, " Stress Analysis as Applied to Design," J. Ward, 7.30 p.m.

Wed., Oct. 7.—MIDLAND BRANCH : Queens Hotel, Birmingham, " Titanium and its Alloys for Chemical Plant," B. J. Conolly, 7.30 p.m.

INSTITUTION OF ENGINEERS AND SHIPBUILDERS IN SCOTLAND

Tues., Oct. 6.—39, Elmbank Crescent, Glasgow, Presidential Address, J. Brown, 6.30 p.m.

INSTITUTION OF LOCOMOTIVE ENGINEERS

Tues., Sept. 22.—Grand Council Chamber, The Federation of British Industries, 21, Tothill Street, Westminster, London, S.W.1, General Meeting : Presidential Address, R. A. Smeddle, 5.30 p.m.

INSTITUTION OF MECHANICAL ENGINEERS

Wed., Sept. 23.—E. MIDLANDS BRANCH : The University, Nottingham, " Development of High-Temperature Materials," H. E. Gresham, 7.15 p.m.

Thurs., Sept. 24.—EASTERN BRANCH : Town Hall, Luton, " Design and Development of Machine Tools," C. A. Sparkes, 7.30 p.m. ★ SOUTHERN GRADUATES' SECTION : College of Technology, Anglesea Road, Portsmouth, " Engineering Experiments at the Harwell Reactor School," H. Bowes, 7 p.m.

Thurs., Oct. 1.—SCOTTISH BRANCH : Royal College of Science and Technology, Glasgow, " New Methods of Exploiting Electronic Computers in the Engineering Industry," H. MacGregor Ross, 7.30 p.m. ★ YORKSHIRE BRANCH : Visit to British Railways Locomotive Works, Doncaster, 2.30 p.m. Mansion House, Doncaster, " The ' Deltic ' Locomotive," C. M. Cock, 6.30 p.m.

INSTITUTION OF NAVAL ARCHITECTS AND INSTITUTE OF MARINE ENGINEERS

Wed., Sept. 30.—SOUTHERN JOINT BRANCHES: Portsmouth College of Technology, Anglesea Road, Portsmouth, " Some Aspects of the Design and Construction of All-Welded Small Craft," Robert du Cane, 7.30 p.m.

INSTITUTION OF PLANT ENGINEERS

Tues., Sept. 22.—SOUTH WALES BRANCH : South Wales Engineers' Institution, Park Place, Cardiff, Technical Films, 7.30 p.m.

Thurs., Sept. 24.—GLASGOW BRANCH : Scottish Building Centre, 425/427, Sauchiehall Street, Glasgow, " Basic Electronics in Industry and Commerce," R. H. Garner, 7.15 p.m. ★ MERSEYSIDE AND NORTH WALES : Exchange Hotel, Liverpool, " Mounting and Maintenance of Roller Bearings," E. Taylor, 7.15 p.m. ★ NORTH-EAST BRANCH : Cleveland Scientific and Technical Institution, Corporation Road, Middlesbrough, " The History and Development of Rotary Air Compressors," 7 p.m. ★ SHEFFIELD AND DISTRICT BRANCH : Grand Hotel, Sheffield, " Rolling Plant," P. A. Clark, 7.30 p.m.

Fri., Sept. 25.—BIRMINGHAM BRANCH : Imperial Hotel, Temple Street, Birmingham, " Works Engineering," R. T. Wells, 7.30 p.m.

Mon., Sept. 28.—WEST AND EAST YORKSHIRE BRANCH : Houldsworth School of Applied Science, The University, Leeds, " Operational Research," G. D. Jordan, 7.30 p.m.

INSTITUTION OF PRODUCTION ENGINEERS

Thurs., Sept. 24.—HALIFAX AND HUDDERSFIELD SECTION : Visit to T. S. Harrison and Sons, Ltd., Union Street, Heckmondwike, 6.30 p.m.

Wed., Sept. 30.—SHREWSBURY SECTION : Technical College, Shrewsbury, " Uses and Developments of Work Study," W. C. Castledine, 7.30 p.m. ★ LOUGHBOROUGH COLLEGE STUDENT SECTION : Visit to J. Lucas, Ltd., S. Block Restaurant, Farm Street, Hockley, Birmingham, 2 p.m.

Thurs., Oct. 1.—LONDON GRADUATE SECTION : Visit to Associated Motor Cycles, Plumstead, 2.30 p.m.

INSTITUTION OF STRUCTURAL ENGINEERS

Thurs., Oct. 1.—11, Upper Belgrave Street, London, S.W.1, Presidential Address, L. E. Kent, 6 p.m.

JUNIOR INSTITUTION OF ENGINEERS

Fri., Oct. 2.—FILM EVENING : Pepys House, 14, Rochester Row, Westminster, London, S.W.1, " The Talilyn Railway—Problems in Preserving a Victorian Narrow-Gauge Railway," 7 p.m.

PHYSICAL SOCIETY

To-day, Sept. 18.—Imperial College, The University of London, Conference on " The Physics of Very High Temperatures," 9.30 a.m.

SOCIETY OF INSTRUMENT TECHNOLOGY

Tues., Sept. 29.—CONTROL SECTION : Manson House, 26, Portland Place, London, W.1, " An Engineer's Approach to a Servo Problem," H. Clausen, 6.30 p.m.

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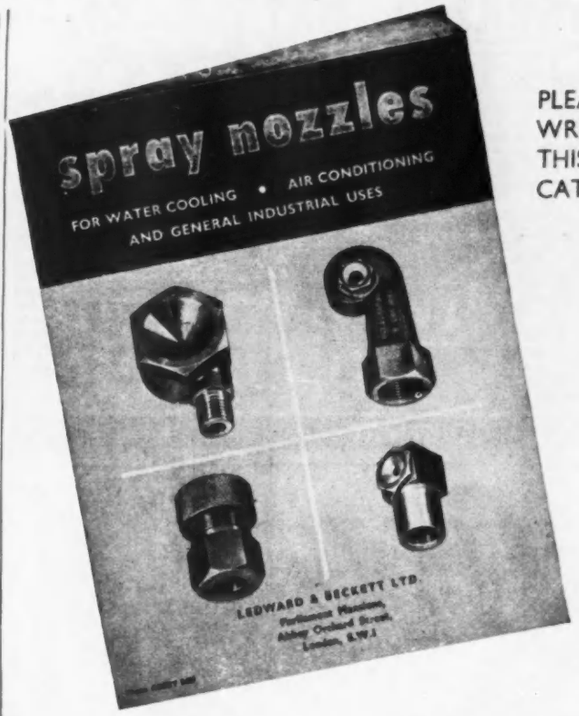

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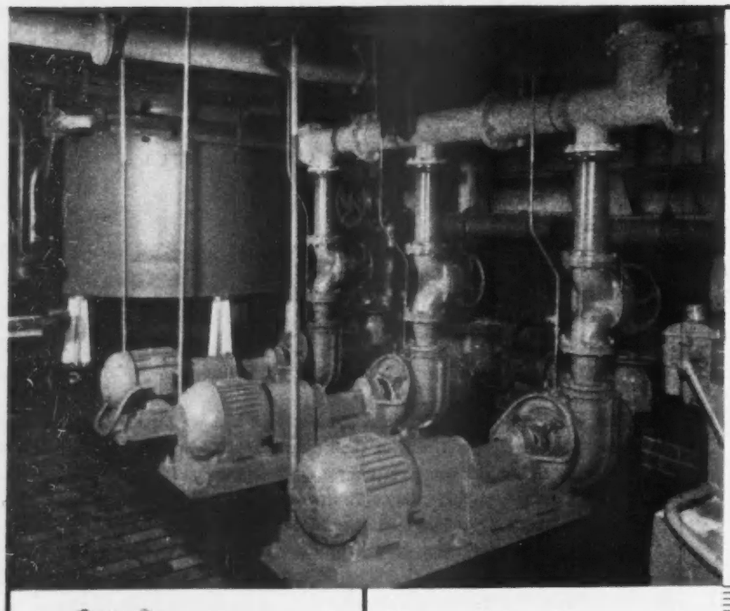

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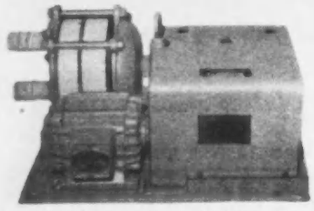
(Bottom right) Portable rotary displacement pump pumping plating solutions in the motor car trade



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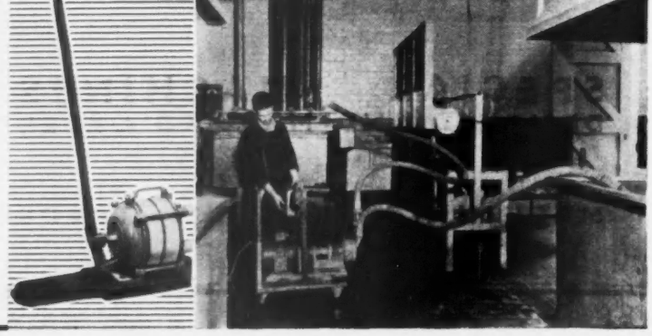

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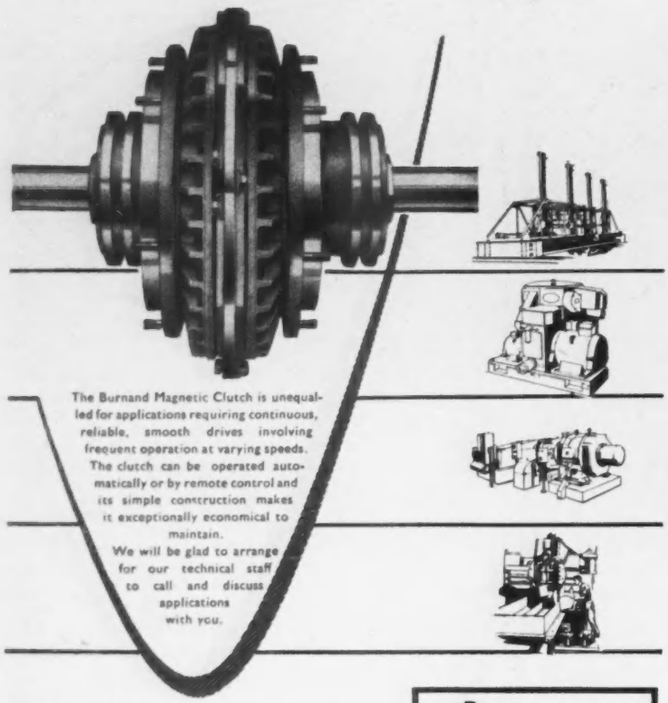

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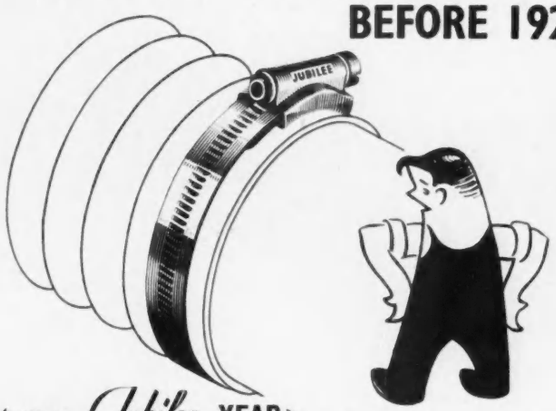

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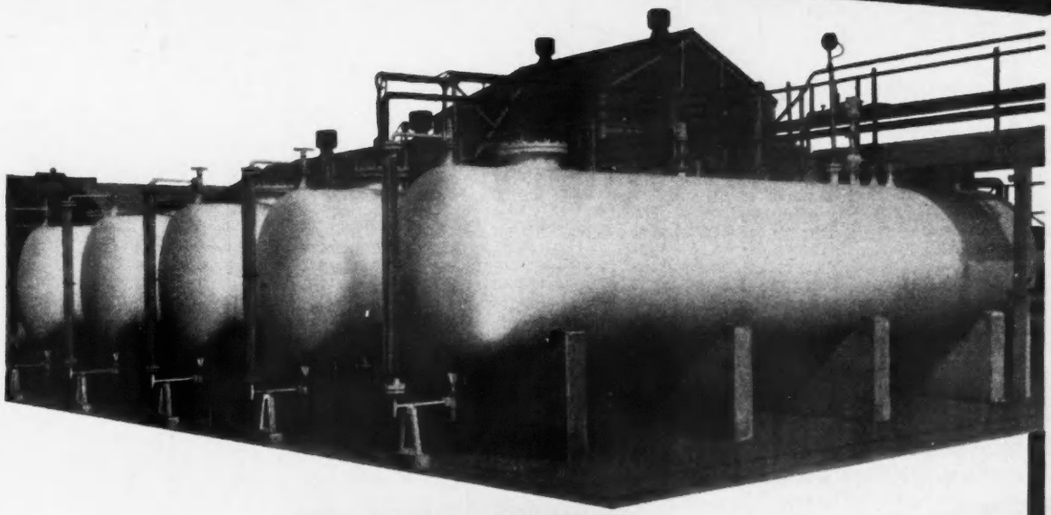

5—Horizontal Pressure Vessels. Dimensions 27′ 3½″ long × 6′ 0″ diameter. Shell ⅝″, Ends 1″ thick. Test Pressure 225 lbs. per sq. inch. A sixth vessel was supplied recently. Illustration by courtesy of National Smelting Company Ltd., Avonmouth.

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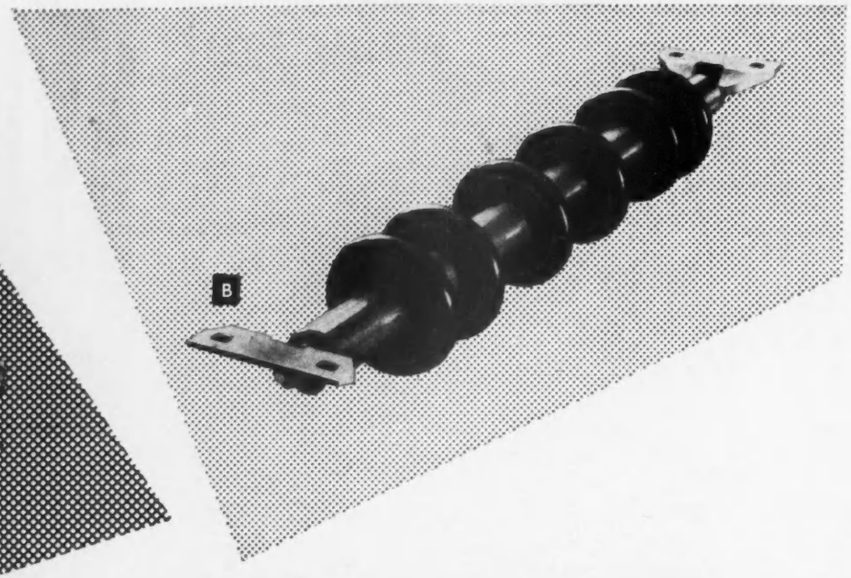

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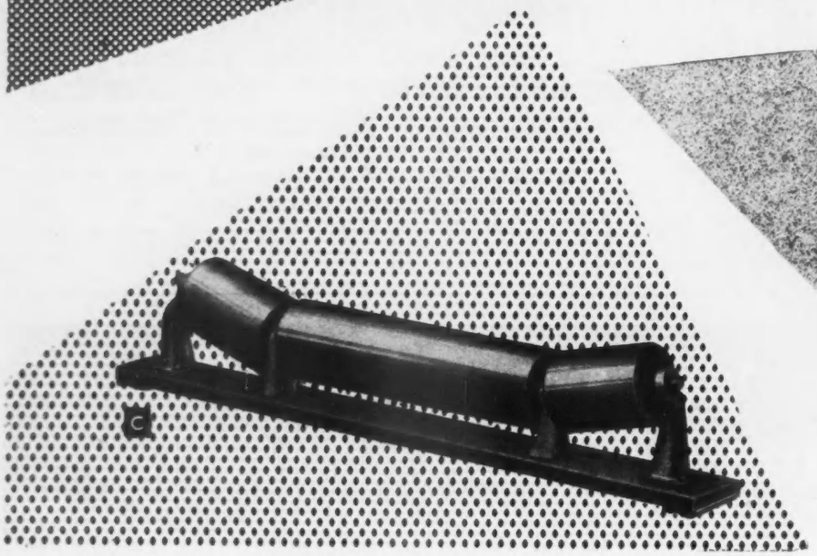

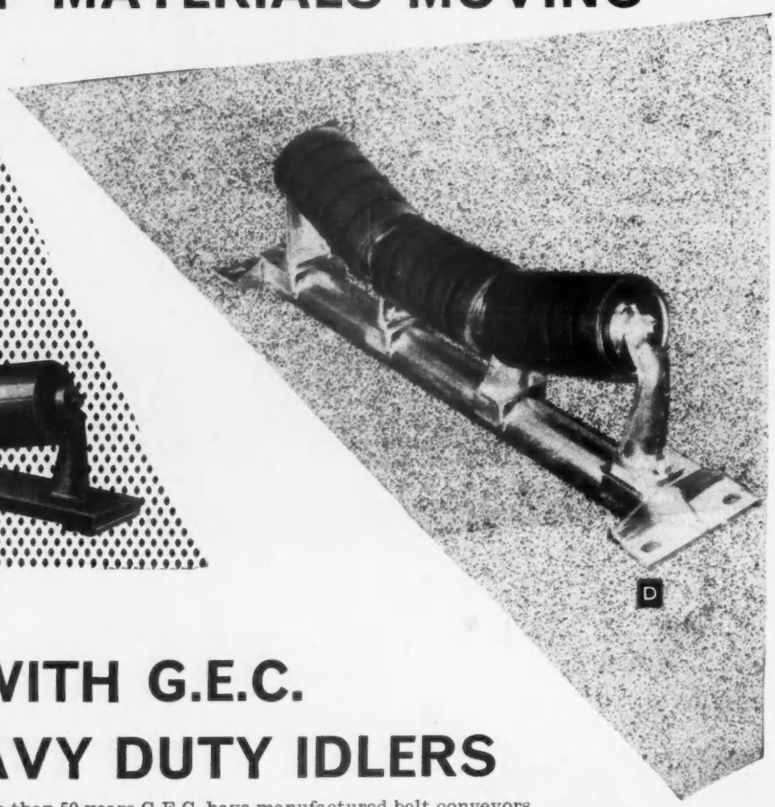

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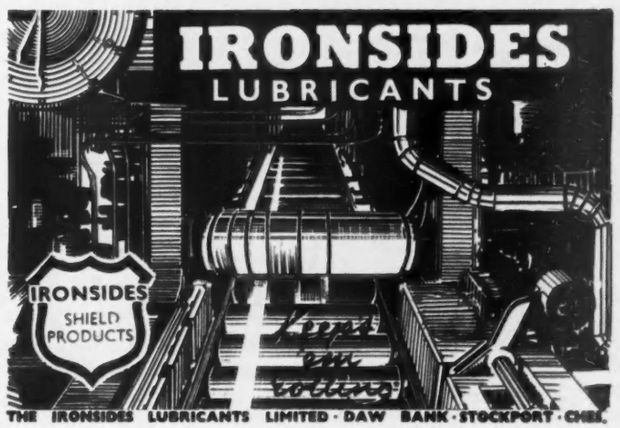

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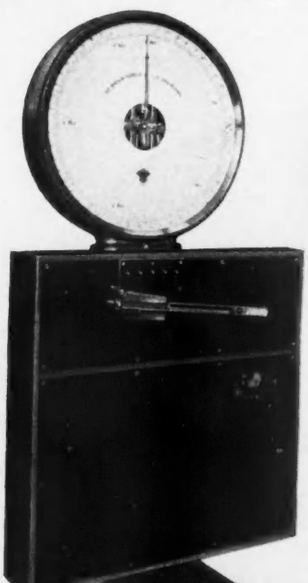

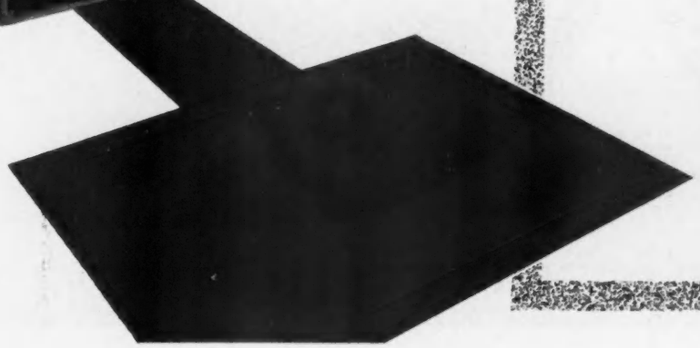

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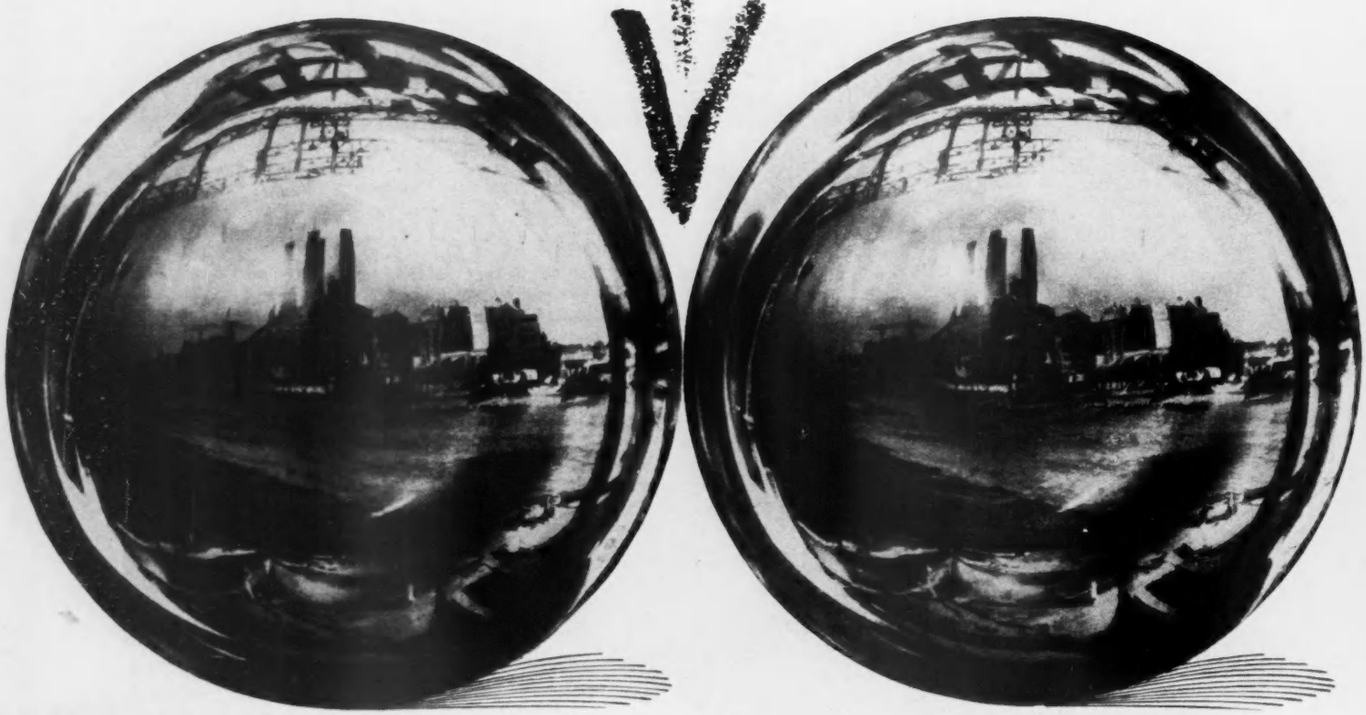

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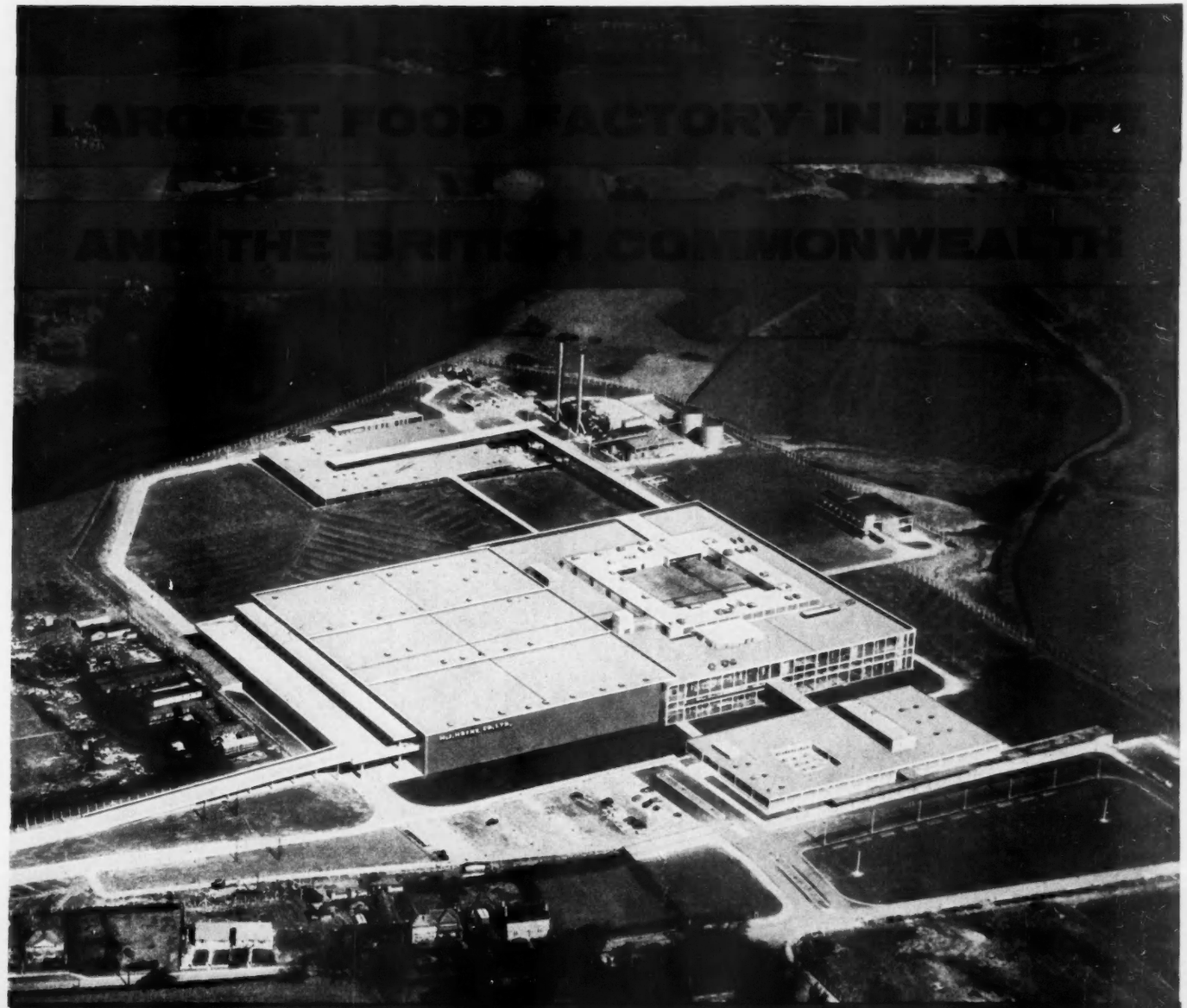

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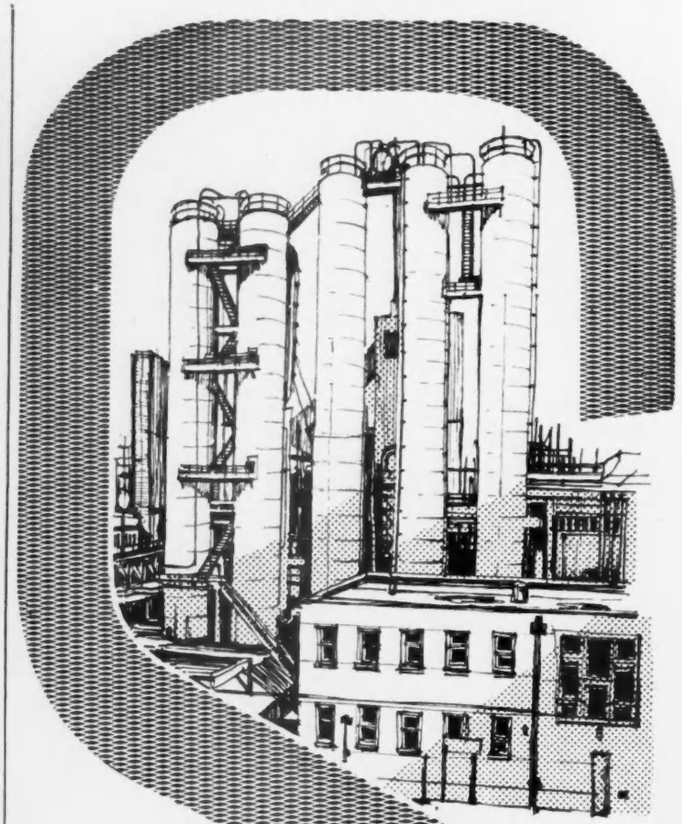

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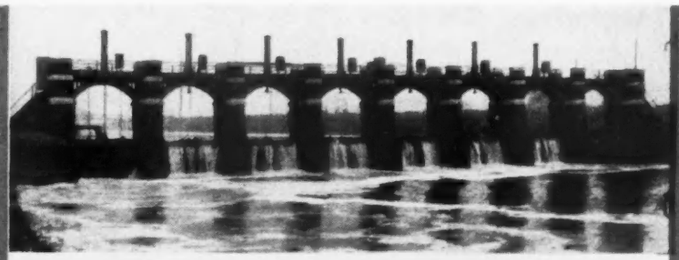

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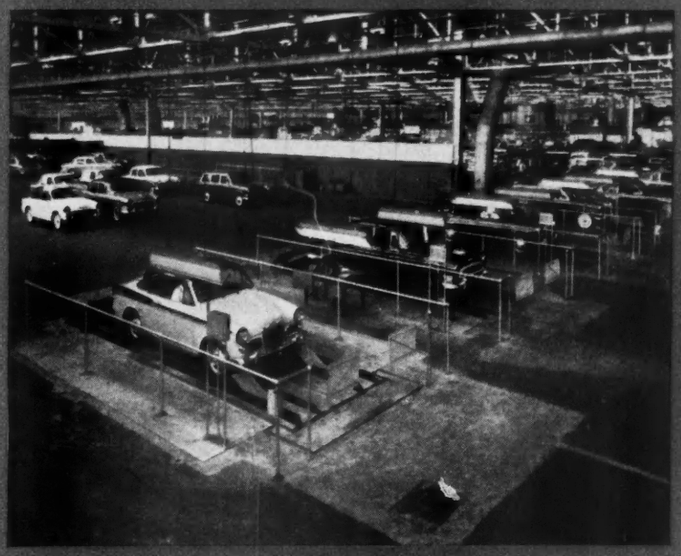

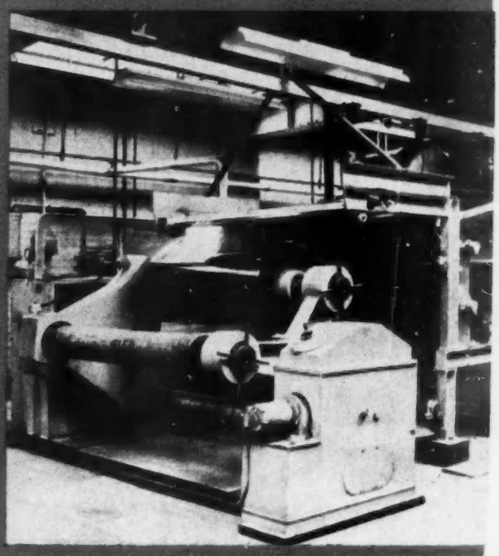

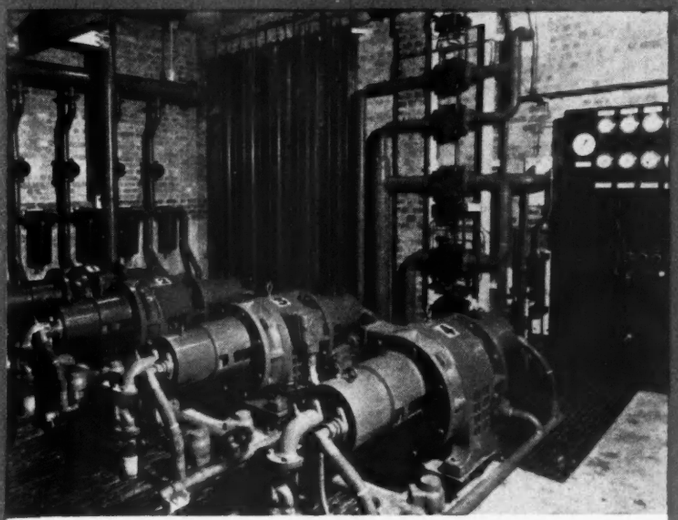

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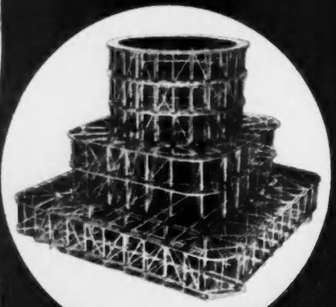

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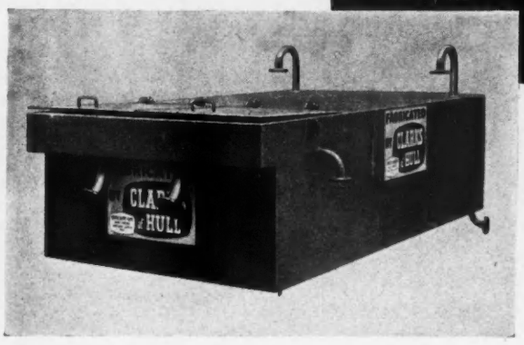

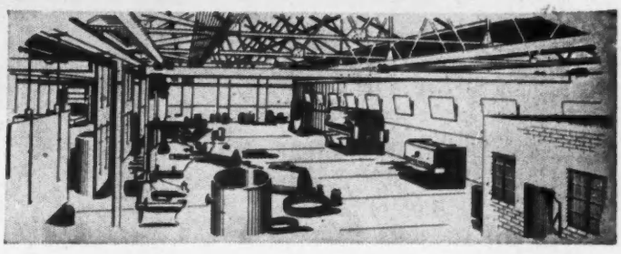

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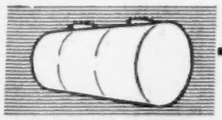

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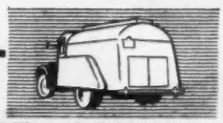

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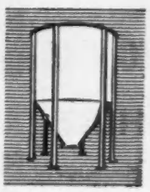

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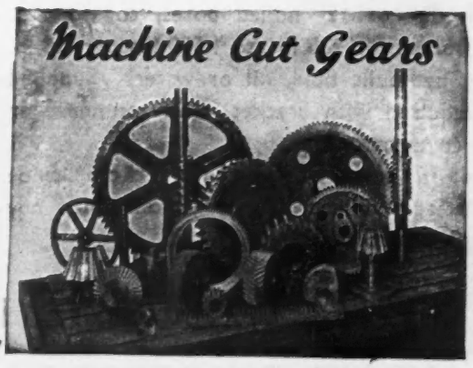

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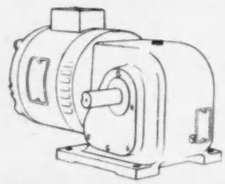

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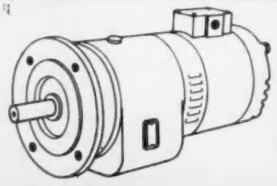

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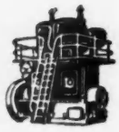

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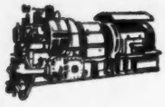

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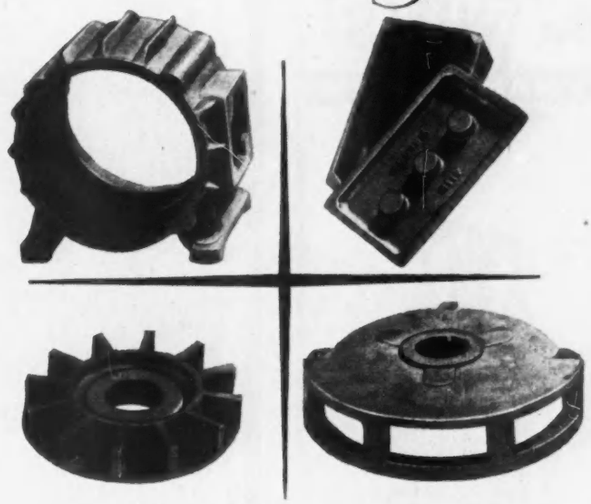

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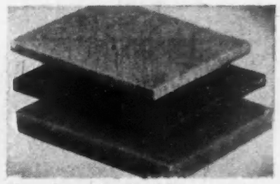

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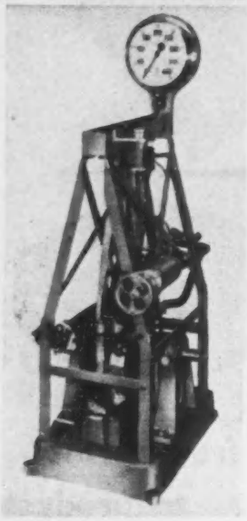

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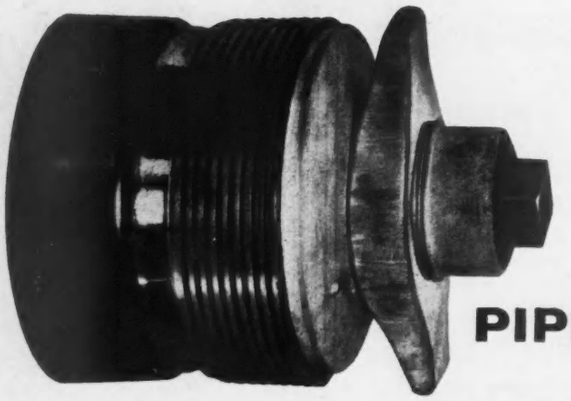

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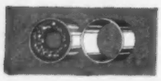

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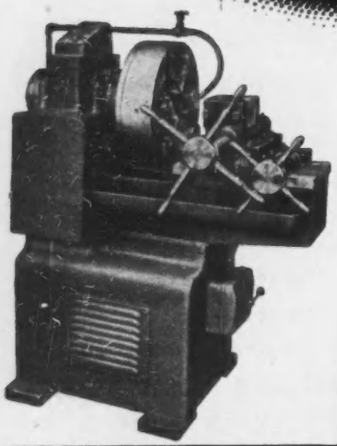

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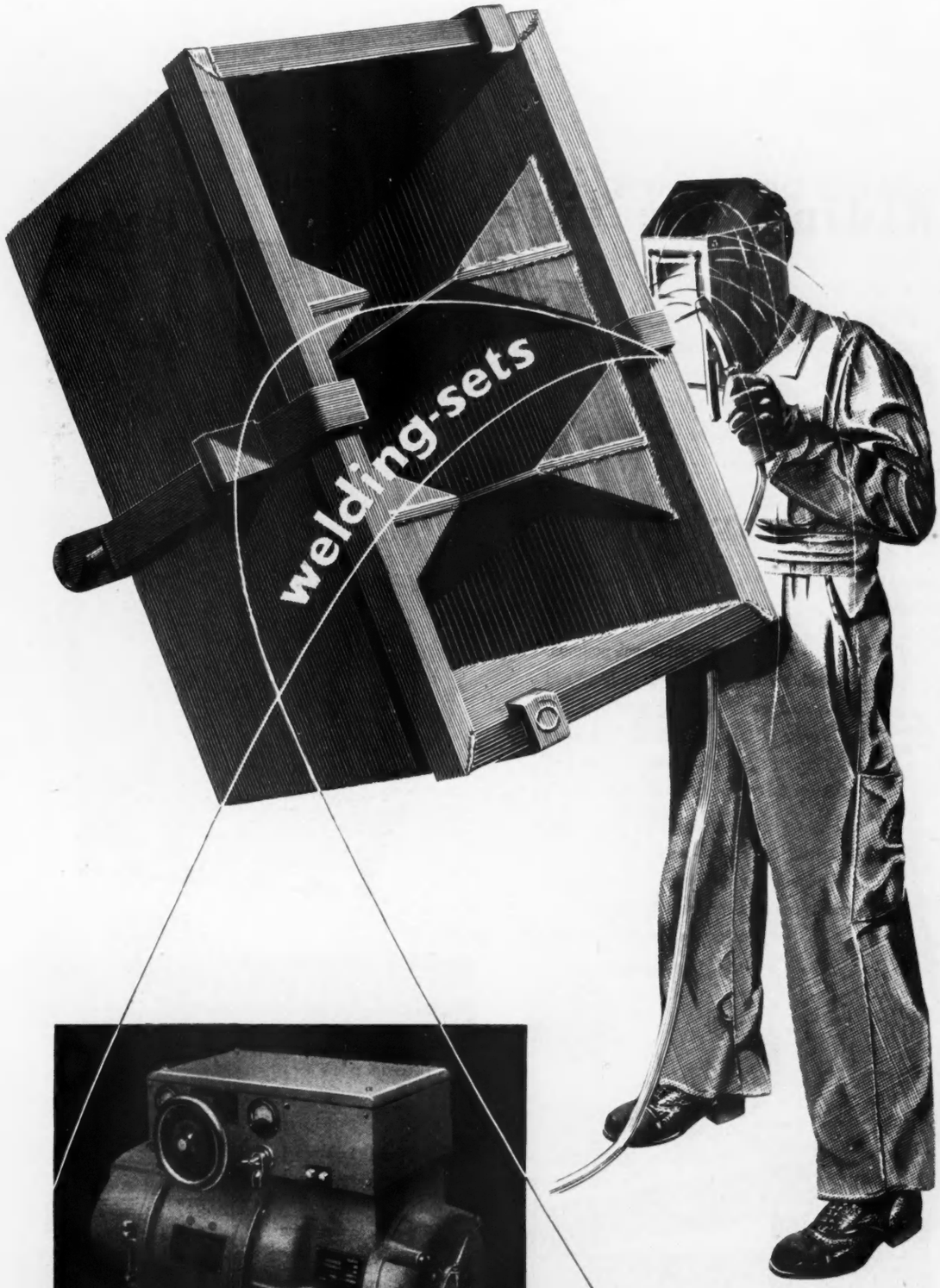

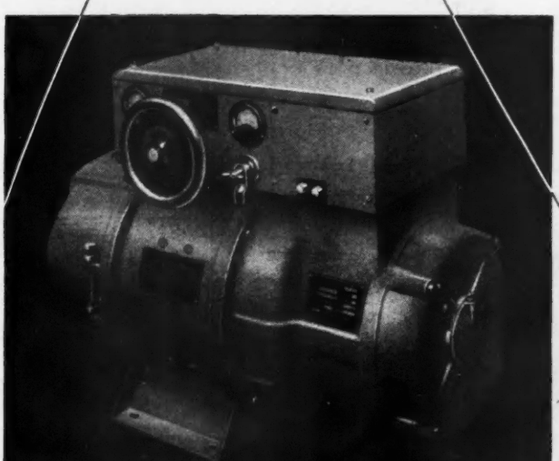

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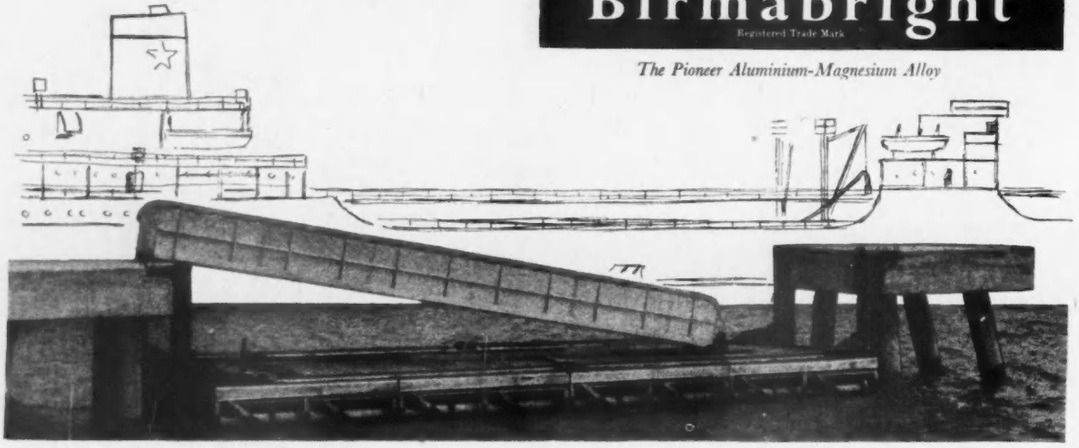

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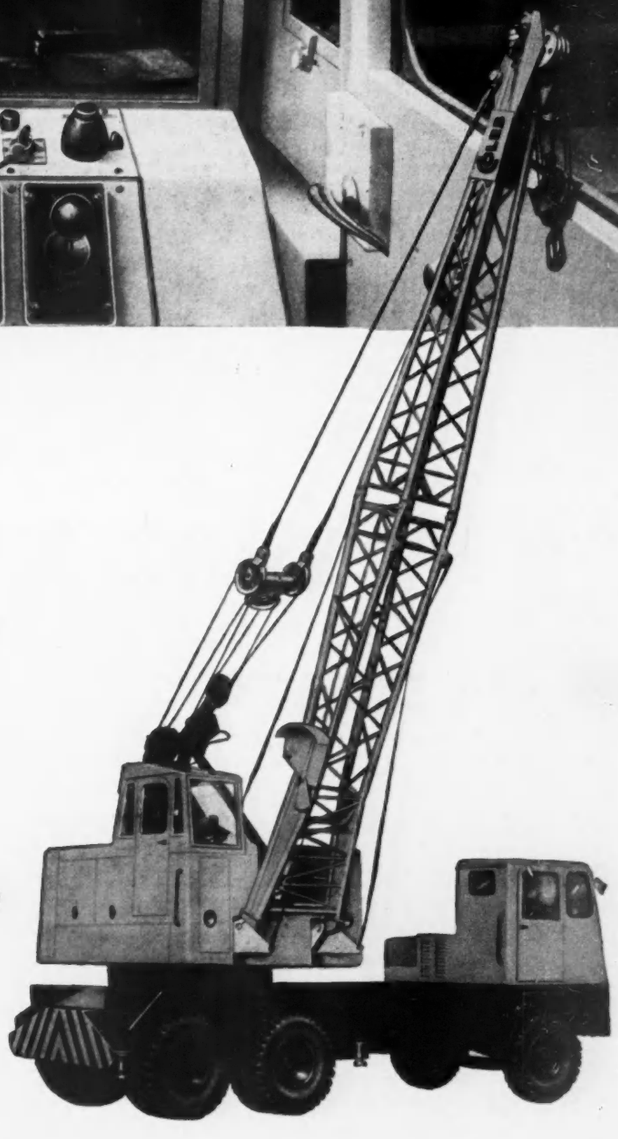

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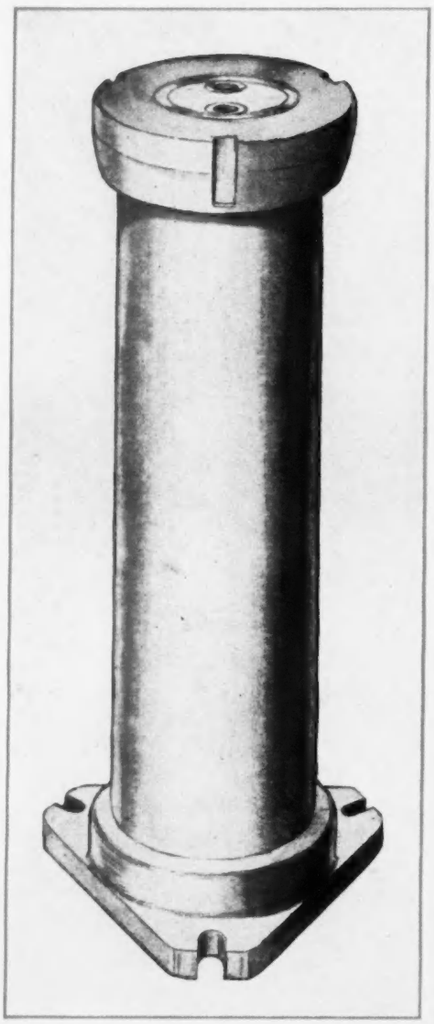

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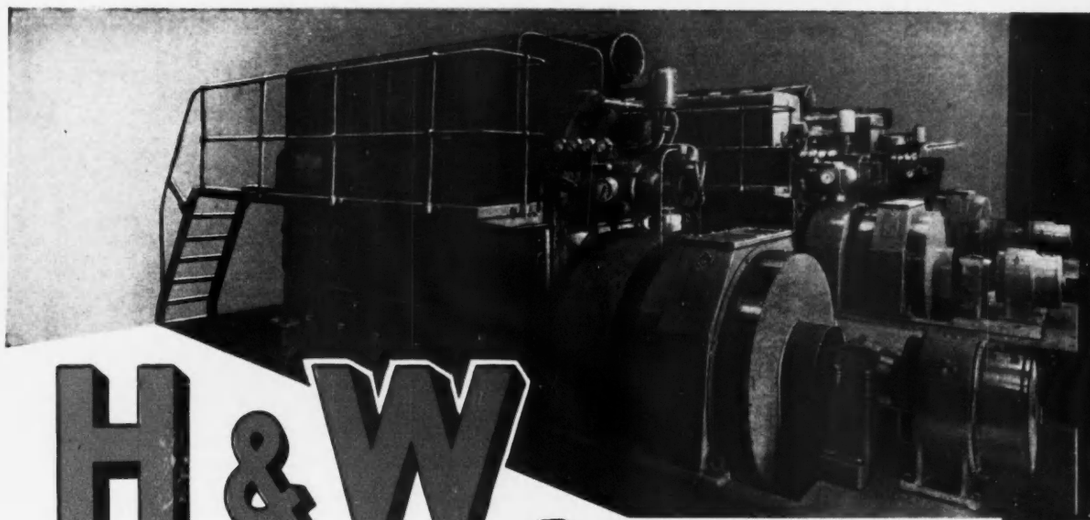

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H & W alternators supplied in all sizes from 60 to 5,000 kVA and voltages up to 11 kV. with H & W 2- or 4-stroke turbo-charged Diesel engines
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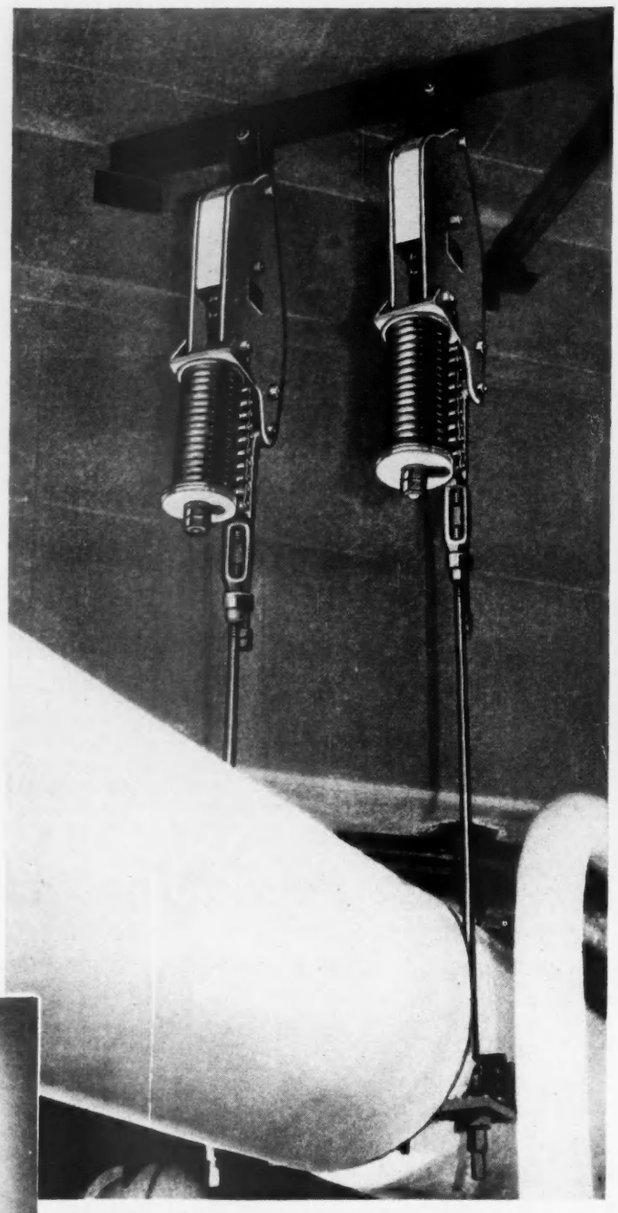
(Regd. Trade Mark)

constant tension supports

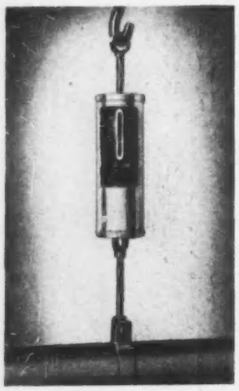
FOR LOADS UP TO 8 TONS
PIPE MOVEMENTS UP TO 18″

High-pressure steam piping is subject to wide variations in temperature, which produce considerable expansion and contraction. Unless the pipe supports can absorb and compensate for this movement, severe stresses are set up which may result in fracture. The " Con-Ten " Pipe Support is designed to cradle any type of piping with constant tension under all conditions, throughout the range of movement. " Con-Ten " is installed, with eminently satisfactory results, in power stations, oil refineries, chemical and industrial plants throughout the world.

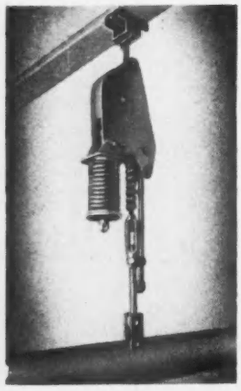
British Patent Nos. 474008 720074 720075 697987 657318
U.S.A. Patent No. 2129320



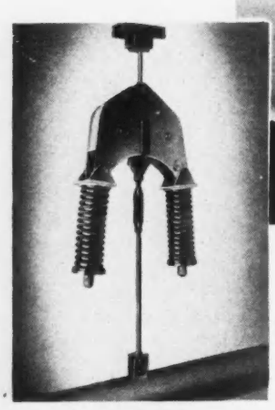
Ferrybridge " B " Power Station, Central Electricity Generating Board, Yorkshire Division. H.P. Steam pipes supplied and installed by Stewarts and Lloyds, Ltd.



Leflbfried Red Top Pipe Supports for loads from 100 to 5,000 lbs. and total travel of 3″.

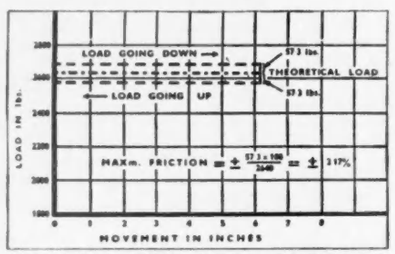


Conventional type " Con-Ten" Supports for loads of up to 2 tons with a total vertical movement up to 12″.



Duplex " Con-Ten " Supports for loads of up to 8 tons with a total vertical movement up to 12″. This type is acknowledged as one which produces minimum friction and kinematic variation. It has been specially designed for any applications where exceptional accuracy is demanded.

From graph it can be seen that the maximum friction is equivalent to 2.17% of the applied load.



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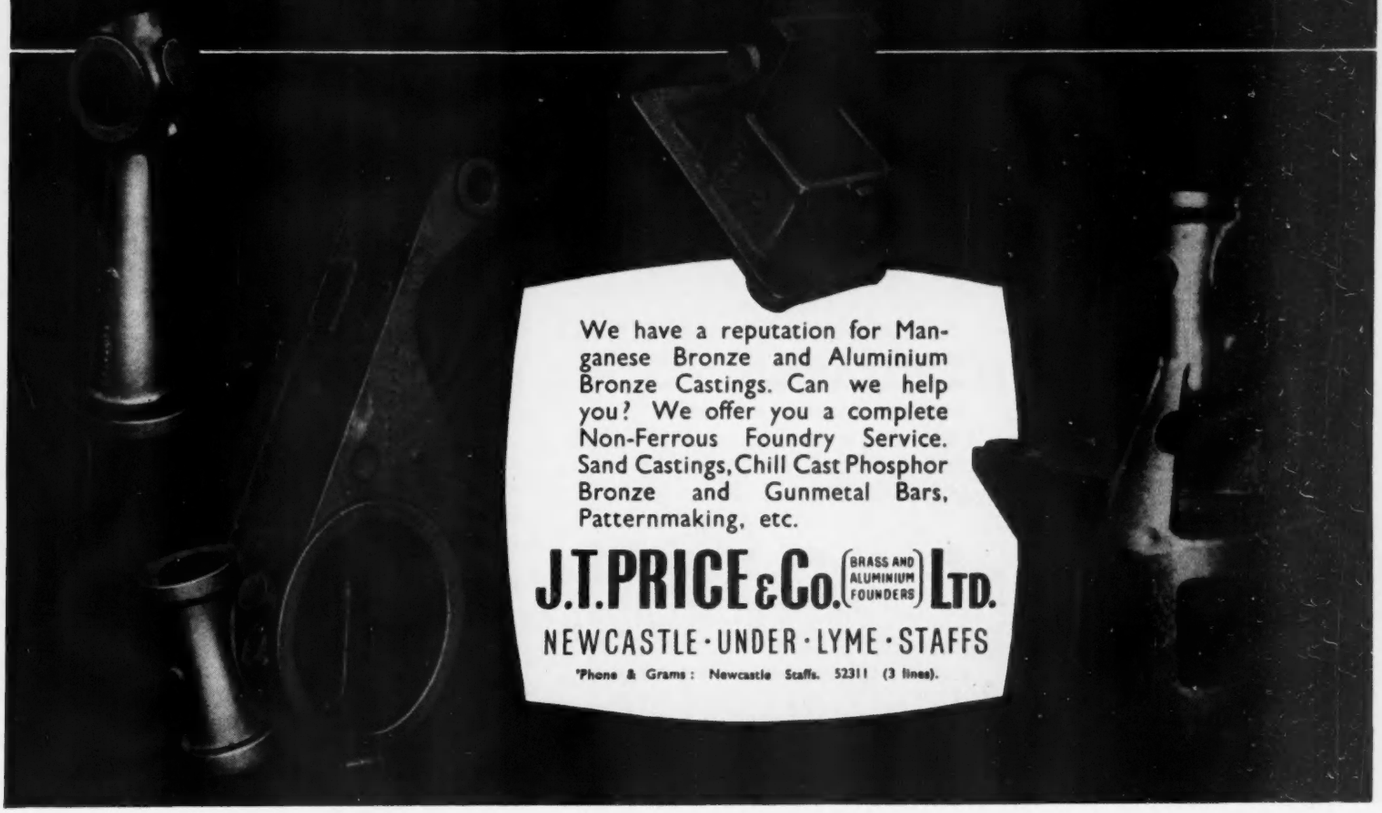

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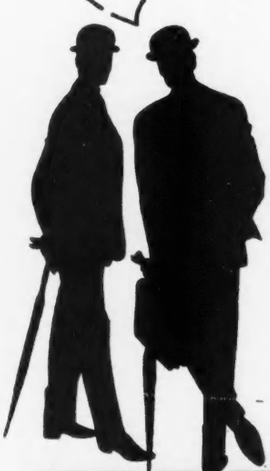

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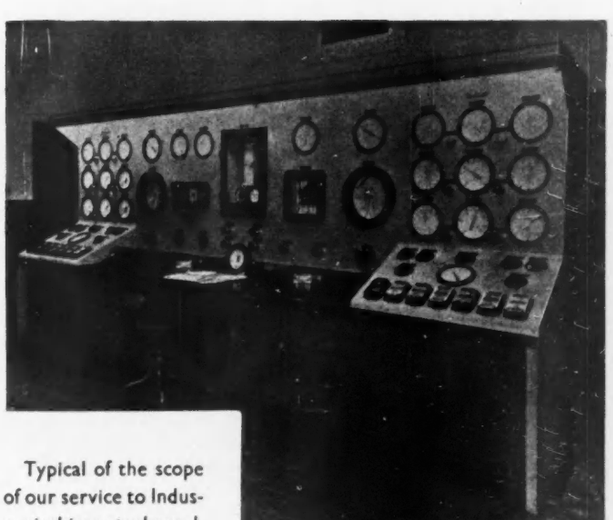

Photo by courtesy of W. H. Allen Sons & Co. Ltd., Bedford.

Typical of the scope of our service to Industry is this control panel. Few production jobs are as simple as they might appear, and this panel, with the high standards of precision and finish required, was no exception. It is installed in the Fulborn Pumping Station of the Cambridge University and Town Waterworks Company.

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for heat, abrasion, corrosion and machining problems

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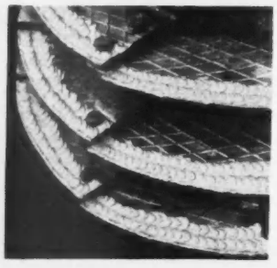

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This machine gives continuous dewatering of crystals leaving a residual moisture content down to 0·6%. When conditions of abrasion are met "Stellite" is used on the blades for protection.

The larger illustration shows the operator depositing "Stellite" on the blades, and the close up, some of these after deposition. The alloy helps the Dynocone to maintain its high efficiency for much longer periods under severe wear conditions.

Illustrations by permission of International Combustion Ltd., Derby

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In this excavation in compacted Thames gravel 28 Jetwells dewatered an average exceeding 50,000 gallons per hour for the whole period of the contract. Contractors who have had experience in excavating waterlogged ground should note the extremely steep batter of the sides, no timbering or other supporting materials whatever being used. The Sykes Jetwells operated at a depth of 25 ft. A small sump 6 ft deeper than the remainder of the excavation was dewatered by the small installation of four Jetwells shown.

figures talk

Robustness, efficiency and simplicity are important characteristics of Sykes Dewatering Equipment, with which contractors' staffs can carry out extensive dewatering of open excavations and trenches without the need for constant supervision.
May we send you further particulars?

SYKES

Photo by courtesy of Gee, Walker & Slater Ltd, to whom the equipment was on hire, and who subsequently purchased considerable quantities of Sykes Dewatering Equipment for use throughout the country.

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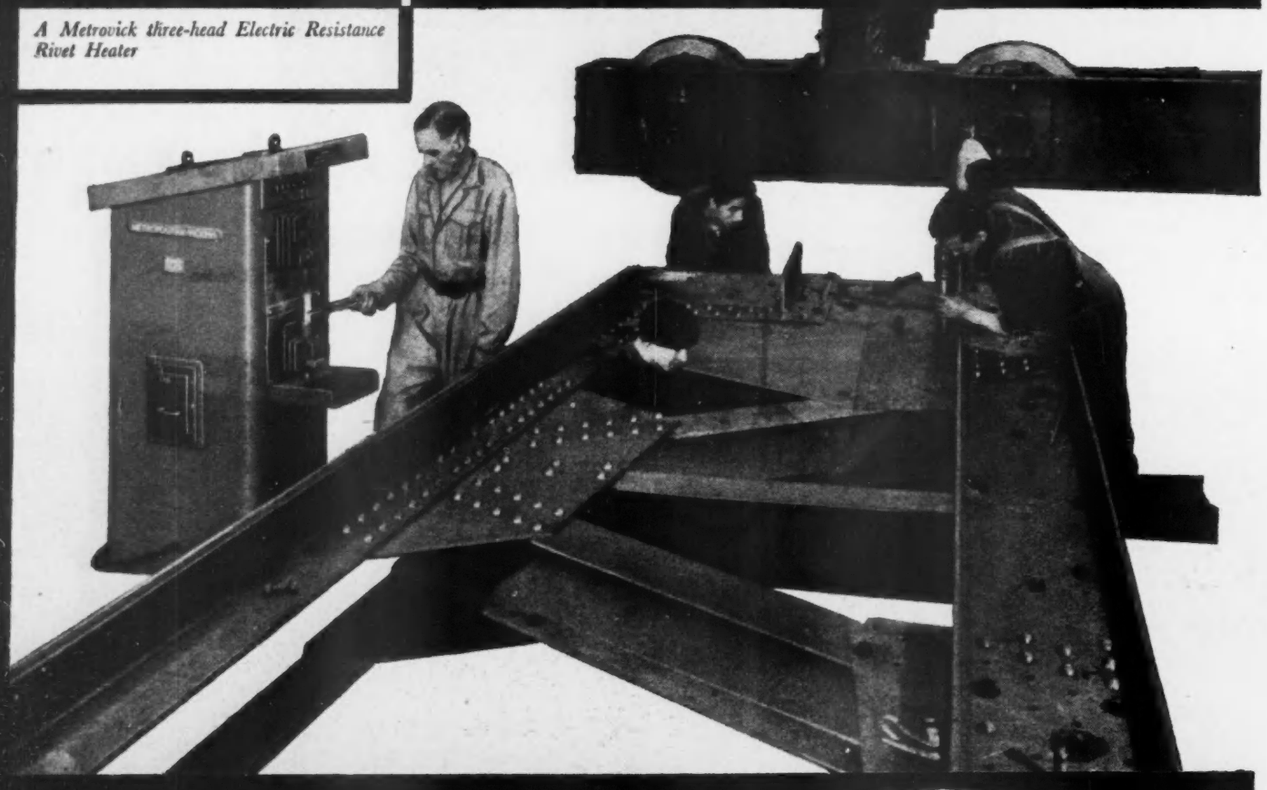
Heat is concentrated in the shanks whilst the heads of the rivets remain comparatively cool; full visibility during heating reduces the risk of burning. The machines are of strong, drip-proof construction enabling them to be used in semi-exposed positions.

A Metrovick three-head Electric Resistance Rivet Heater

CHARACTERISTIC DATA *(Applicable to each head)*

Equivalent continuous rating (kVA)	10	17	25
Maximum input in normal operation (kVA)	15	25	35
Normal heating range for M.S. rivets	$\frac{5}{16}$ in. x 1 in. to $\frac{7}{8}$ in. x 4 in.	$\frac{3}{8}$ in. x $1\frac{1}{4}$ in. to $1\frac{1}{8}$ in. x 4 in.	$\frac{3}{8}$ in. x $1\frac{1}{2}$ in. to $1\frac{1}{4}$ in. x 6 in.
Average output in lb. per hour	40	65	90



A Metrovick single-head electric rivet heater in use for heating rivets for a 100-ton crane at the Winsford, Cheshire, factory of Messrs. Henry Smith & Company Limited

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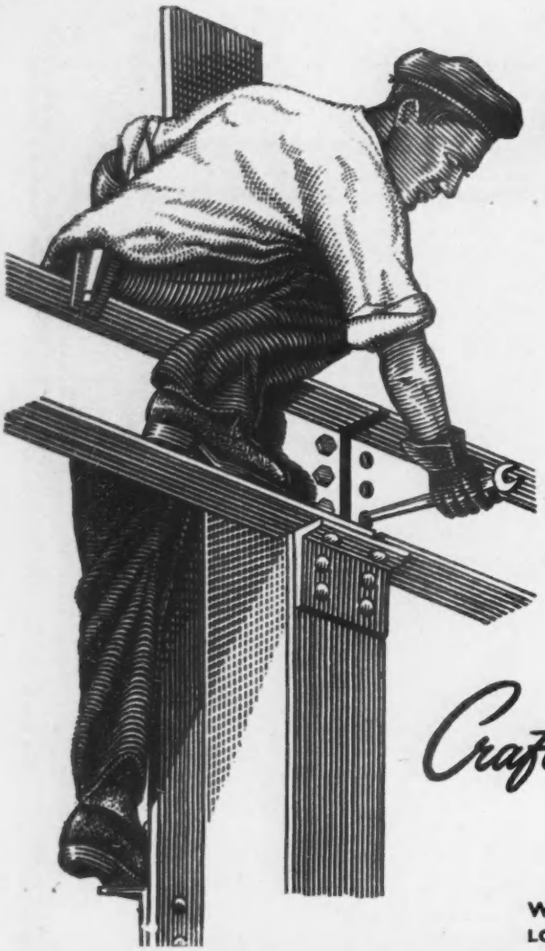

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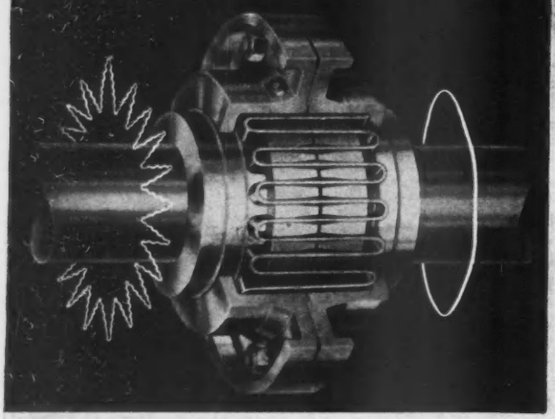

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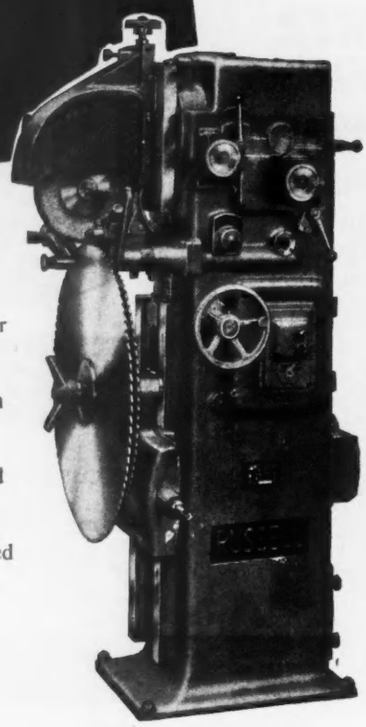

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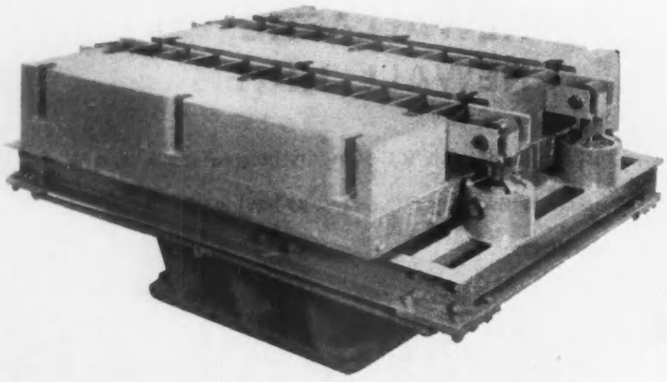

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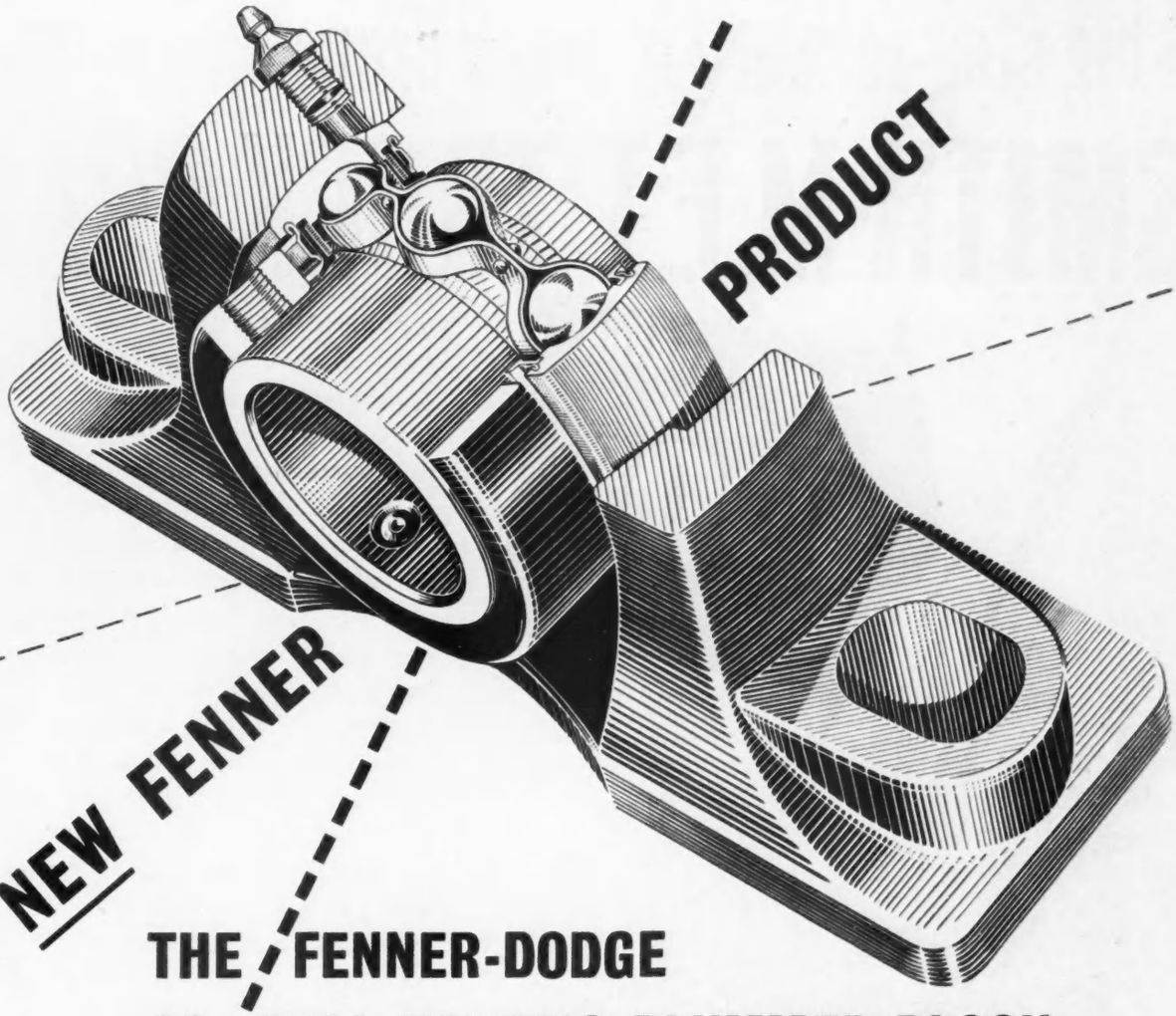

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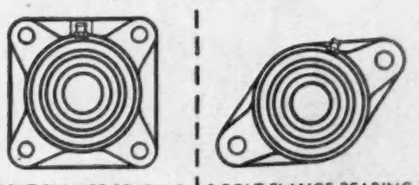

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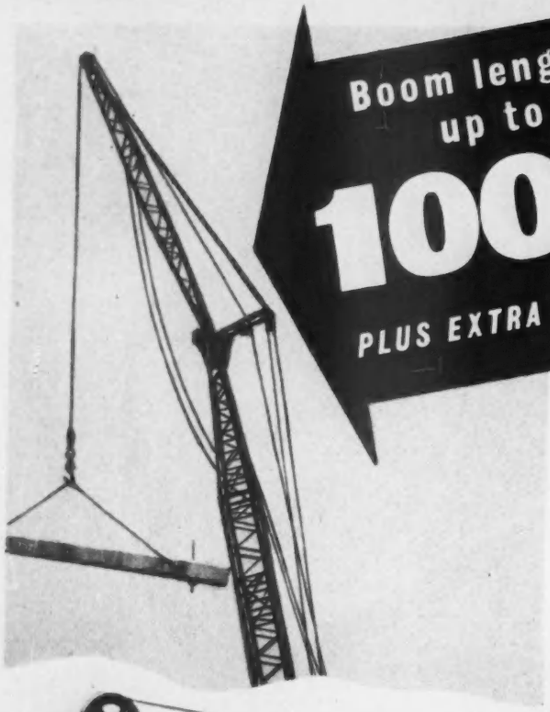

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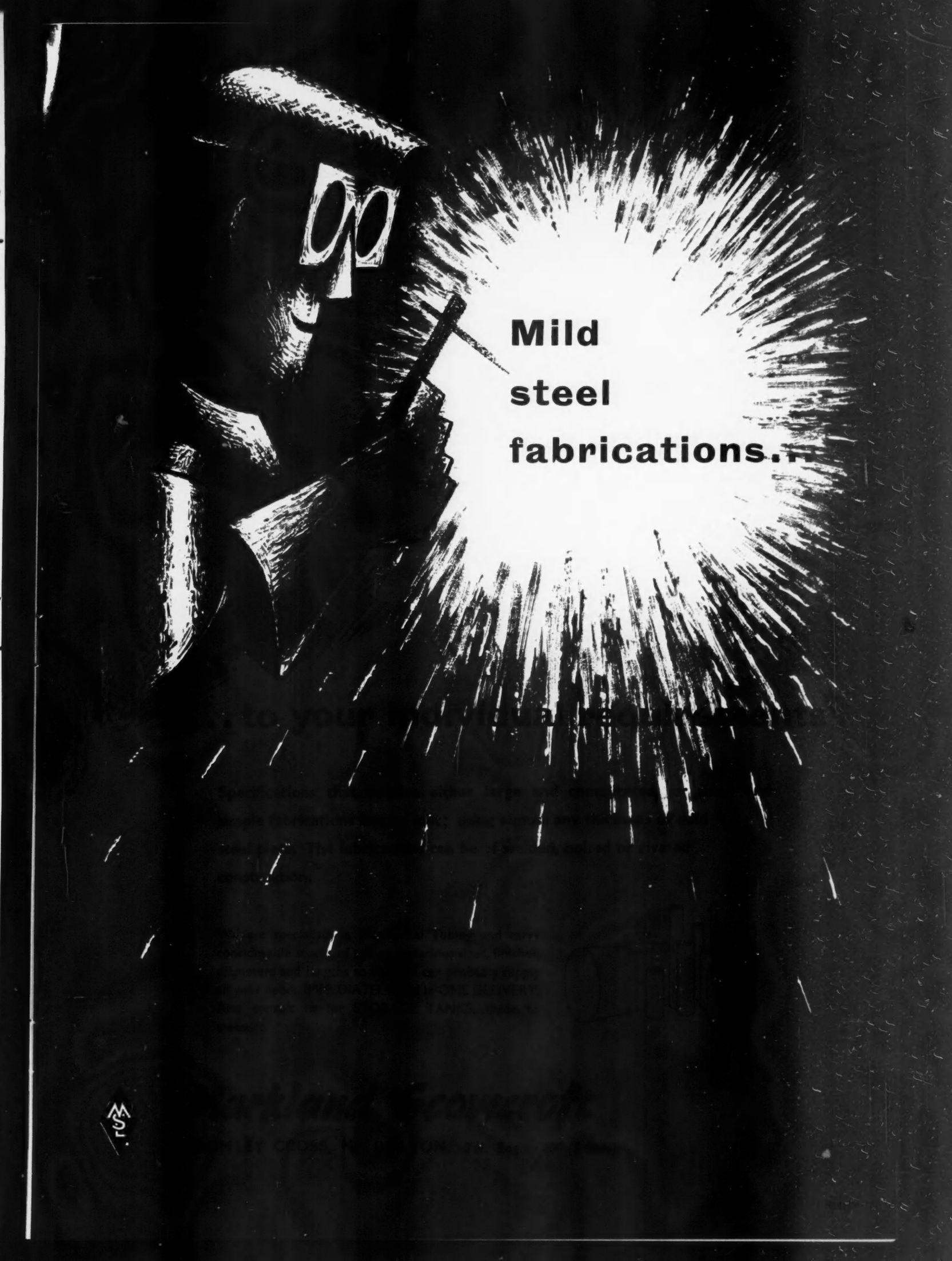
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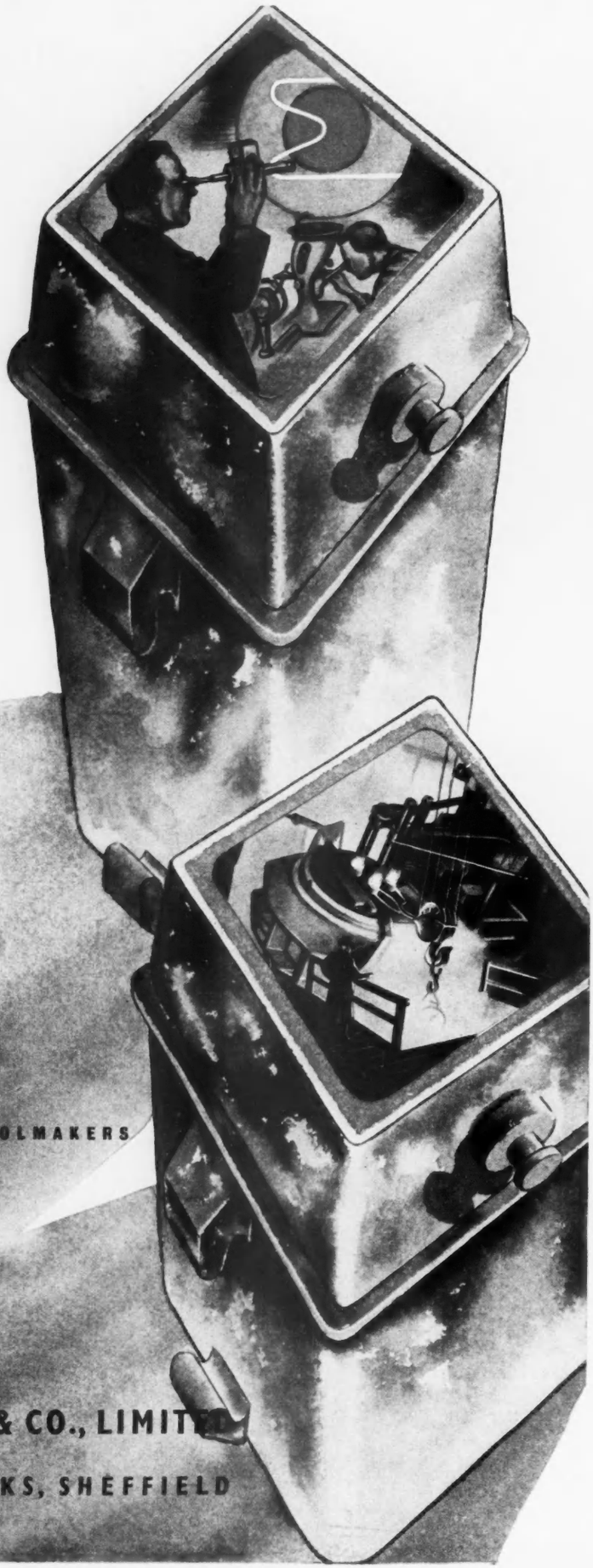

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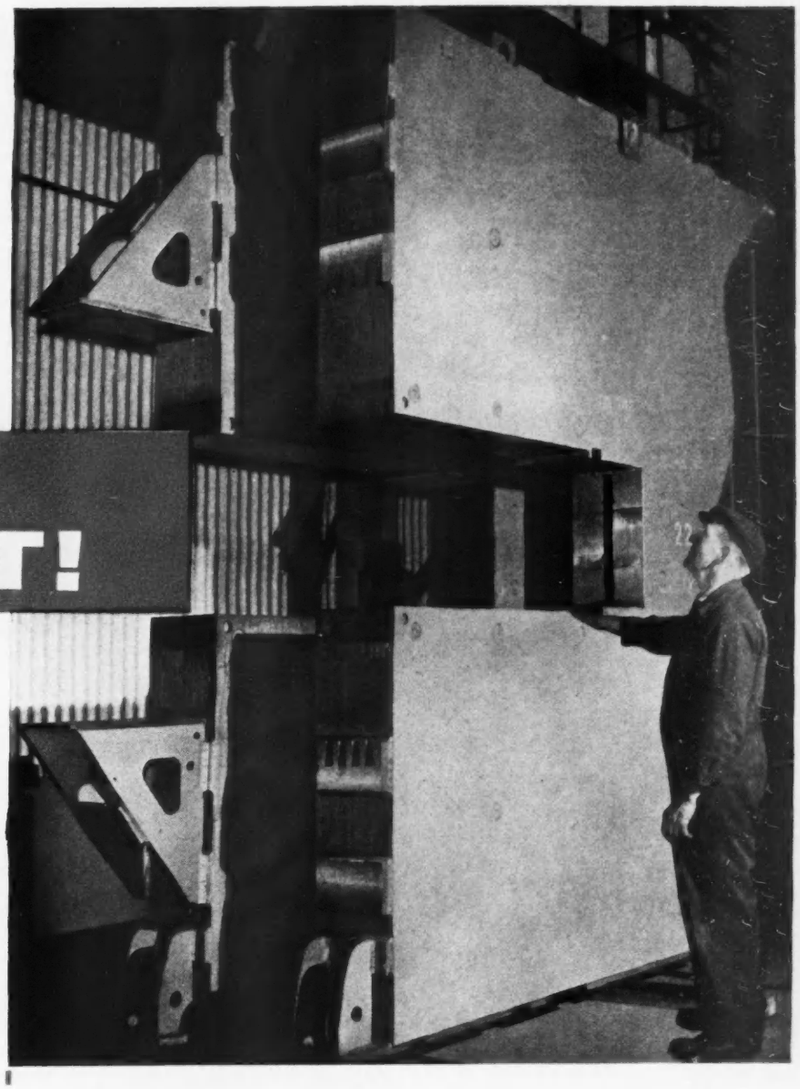

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The Hick Hargreaves Rotary Strainer is available in a range of capacities up to 5,000,000 g.p.h. with mesh of $\frac{1}{16}$" to $\frac{1}{4}$" diameter inscribed circle.

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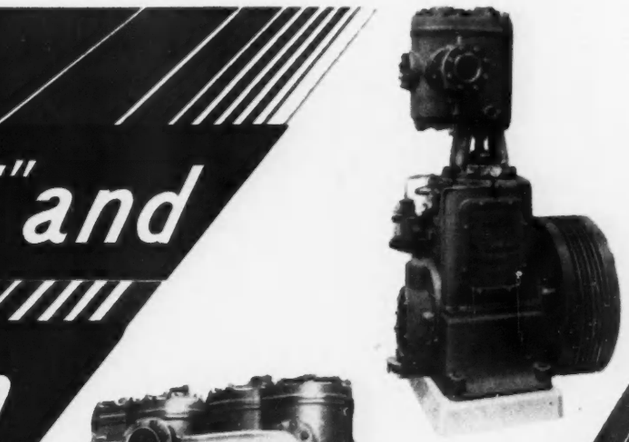

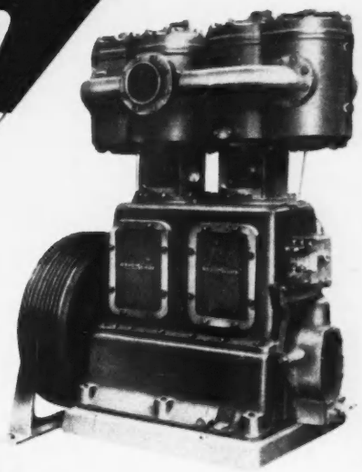

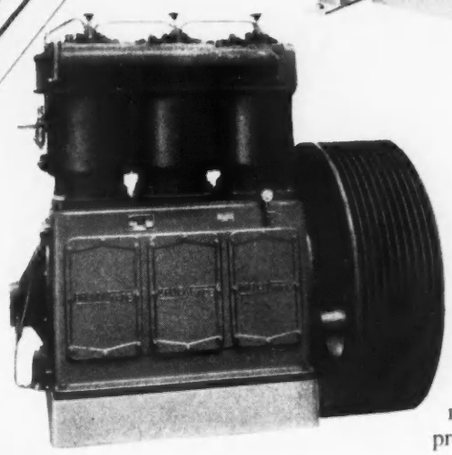

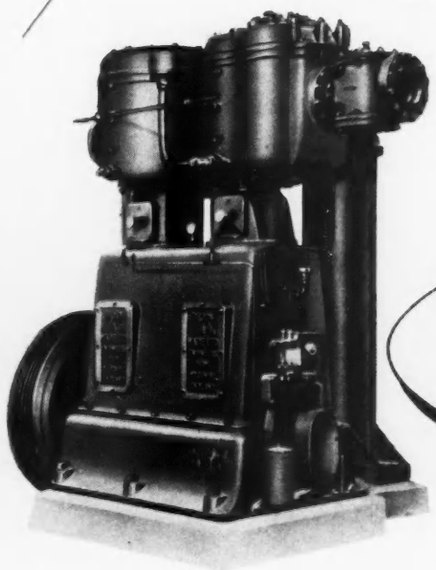

Another industrial revolution is in progress. Industry is becoming more and more highly mechanised—automation is being recognised as a necessity in the progressive, modern factory. In this advancement, compressed air is playing a vital part.

To keep the production lines moving at the new automation speed, reliable plant is essential. For over sixty years "BROOMWADE" pneumatic equipment has enjoyed an enviable reputation for RELIABILITY and EFFICIENCY. Continuous research and development keeps "BROOMWADE" products one step ahead.

The "BROOMWADE" organisation invites consultation on any technical problems involving the use of compressed air.

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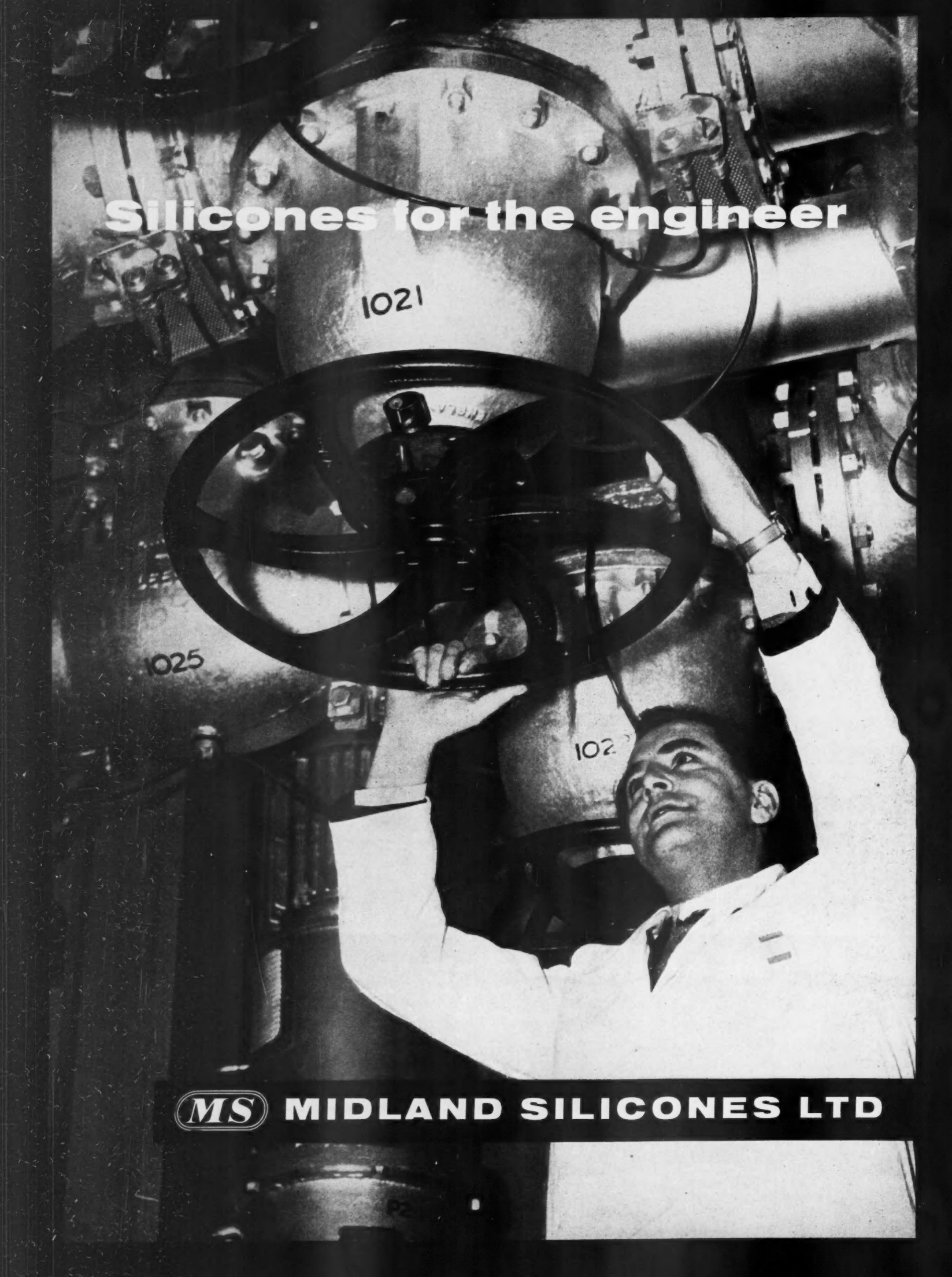
Silicones for the engineer
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MIDLAND SILICONES LTD

MS

*Silastomer silicone rubber withstands temperature extremes

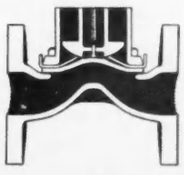
Because of their excellent temperature stability diaphragms of Silastomer silicone rubber are used in many of the various types of valves manufactured by Saunders Valve Co. Ltd. Silastomer will remain serviceable at temperatures as low as −70°C, where other rubbers harden and become brittle, and as high as +250°C, where organic rubbers char and decompose. Silastomer is also resistant to a wide range of chemicals.

Apart from their use as valve diaphragms Silastomer silicone rubbers have many applications as seals and gaskets which must remain durably resilient at elevated temperatures. Grades are available to resist petrol, lubricating and hydraulic oils. Silastomer is also used in paste form as a high temperature caulking and sealing compound and can be coated on to glasscloth for use as heat resistant sleeving, ducting and diaphragms.

The photograph shows one of the many types of Saunders Valves in use in industry.

BY COURTESY OF SAUNDERS VALVE CO. LTD.

The sectional view shows the resilient diaphragm in the Saunders Valve. The excellent temperature stability of silicone rubber diaphragms enables these valves to be used for conveying gases and chemicals at extremes of temperature.



* SILASTOMER IS A REGISTERED TRADEMARK OF MIDLAND SILICONES LTD.

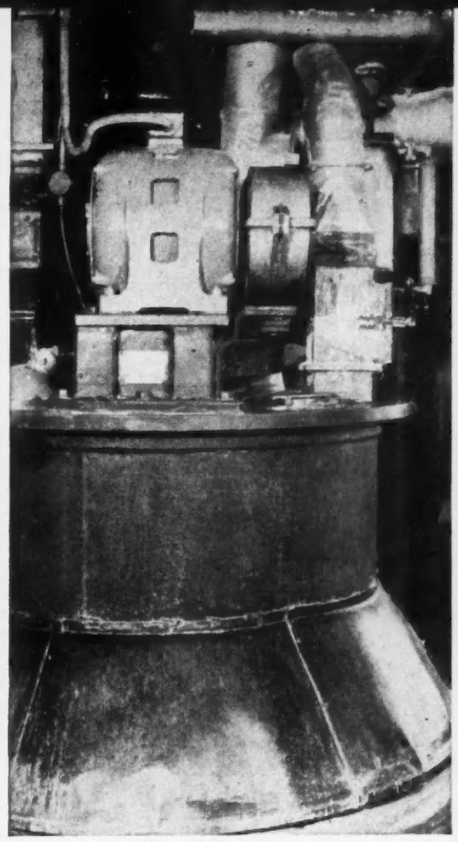


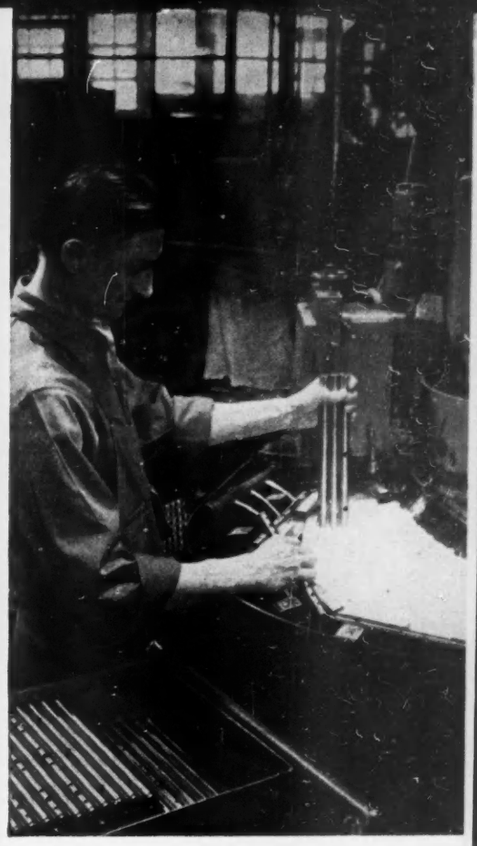
Photo by courtesy of Thomas Hedley Co. Ltd.

MS

Silicone motor rewind saves £400

Thomas Hedley & Co. Ltd., at the company's West Thurrock factory, found that one of their motors working in a particularly wet position, on a mixing tank used in the manufacture of synthetic detergents, broke down at average intervals of 6 months. Rewinds were tried in Class A insulation (costing £30 each time), and in Class B insulation with extra varnish dips to give additional protection against moisture – both without success. Finally they tried a silicone rewind. This was nearly seven years ago and the motor has been operating since without failure, thus saving approximately £400 in rewind costs. In addition losses in production time due to motor failure have been eliminated.

MS silicones strengthen the weak link in all forms of electrical equipment – its insulation. With silicone-insulated motors the risk of breakdown through insulation failure is very greatly reduced. Have your most troublesome motors rewound with silicone insulation. Write to Midland Silicones for names of rewinders with experience in using silicone insulation.



MS

Antifoam kills foam –boosts output

Kill foam and increase the productive capacity of machine tools with a highly efficient MS silicone defoamer. The water and oil coolants used in the heavy-duty grinders shown in the photograph foamed so badly that it was necessary to shut the machine down for 15 minutes of every hour just to clear foam away. Conventional foam inhibitors were partially effective, but reduced the efficiency of the coolant.

A silicone antifoam agent was added to the coolant and foam vanished immediately – "like a punctured balloon" – and hourly grinder output increased 25%.

MS silicone defoamers are effective in low concentrations making them most economical in use. They will remain stable for long periods in either hot or cold storage conditions.

There is an MS silicone antifoam agent in the form of a compound, fluid or emulsion to deal with your particular foaming problem.

First in British Silicones

Write for full information about these and the many other silicone products with applications in the engineering industry including release agents, damping and hydraulic fluids, heat-resistant paint, resins, lubricants and electrical insulants.

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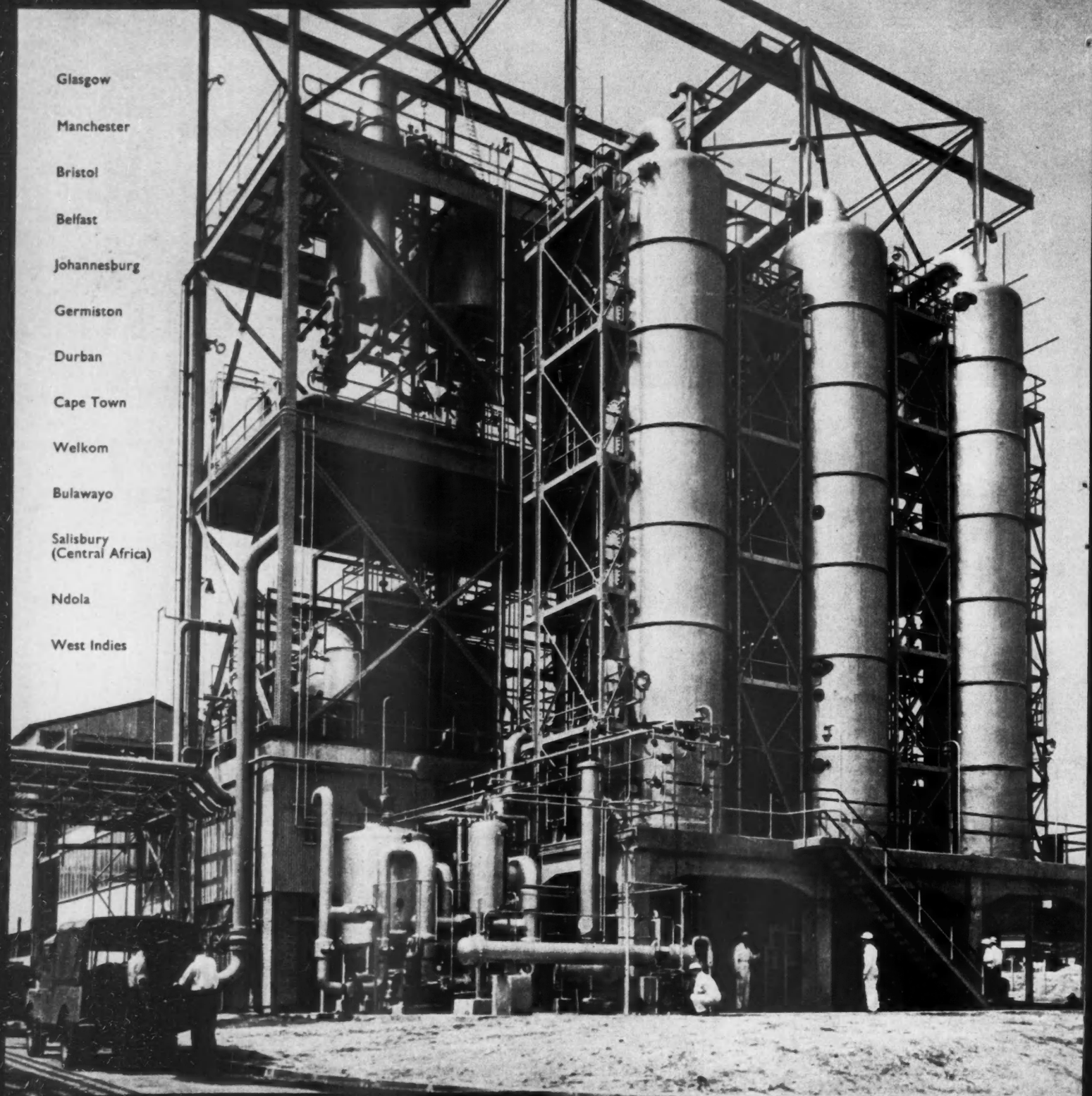

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Try This Test

Epimastic's toughness is only matched by its adhesion to metal. Above—showing a plate bent almost double without any loss of adhesion between coating and metal surface.

Few coatings resist the hard knocks of a full working life. Mechanical damage is a short cut to the subsequent failure of any coating and no engineer can afford to take risks. Epimastic has been found to withstand an amazing amount of abrasion and rough treatment and yet still provide an efficient protection against corrosion.

Solvent and moisture proof, resistant to all manner of corrosive chemical conditions, Epimastic will probably provide the answer to your corrosion problem. Write today for Technical Leaflet No. 20.

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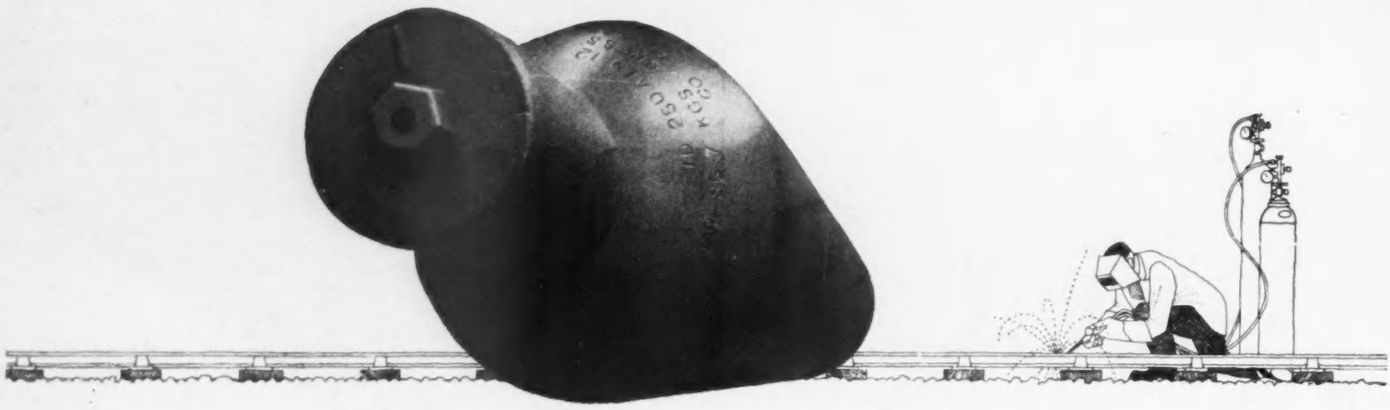

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At Chesterfield we can look back on over fifty years' experience in punching and drawing stubborn billets of steel into every shape and size of tube and hollow. This experience helps us to turn out impressive numbers of pressure vessels and gas bottles too. Whether you're on or off the beaten track, you are likely to come across the familiar shape* of a Chesterfield gas cylinder—one of over 9,000,000 already serving the needs of industry, medicine and construction the world over.

**Chesterfield gas cylinders are cold drawn, seamless and as perfect as our modern plant and manufacturing technique can make them. Chesterfield Cold Drawn Seamless Steel Gas Bottles are manufactured to conform to the specifications and regulations prescribed by the competent Authorities in all countries.*

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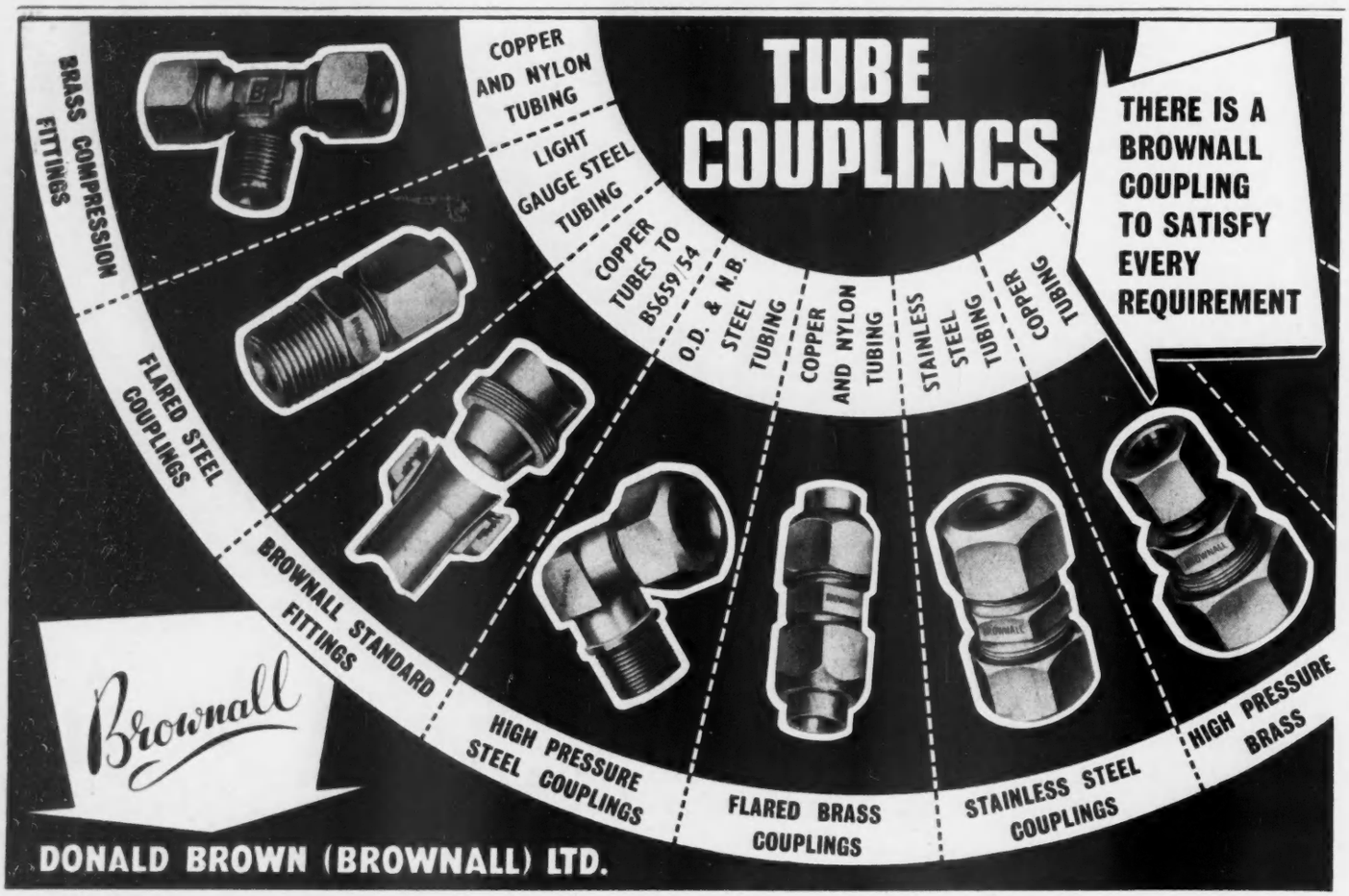

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KARIBA at 330 kV.

All the bushing porcelains for
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All the 330 kV. strain insulators
for the substations
and the 330 kV. post insulators
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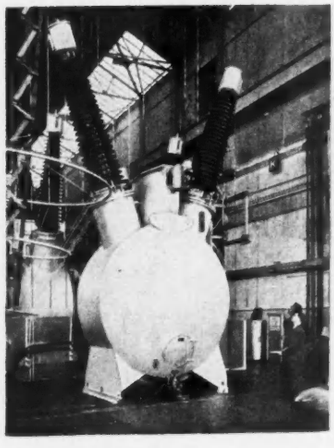

The illustrations show a complete 330 kV. bushing insulator and a 330 kV. circuit breaker, by courtesy of the B.T.H. Co.

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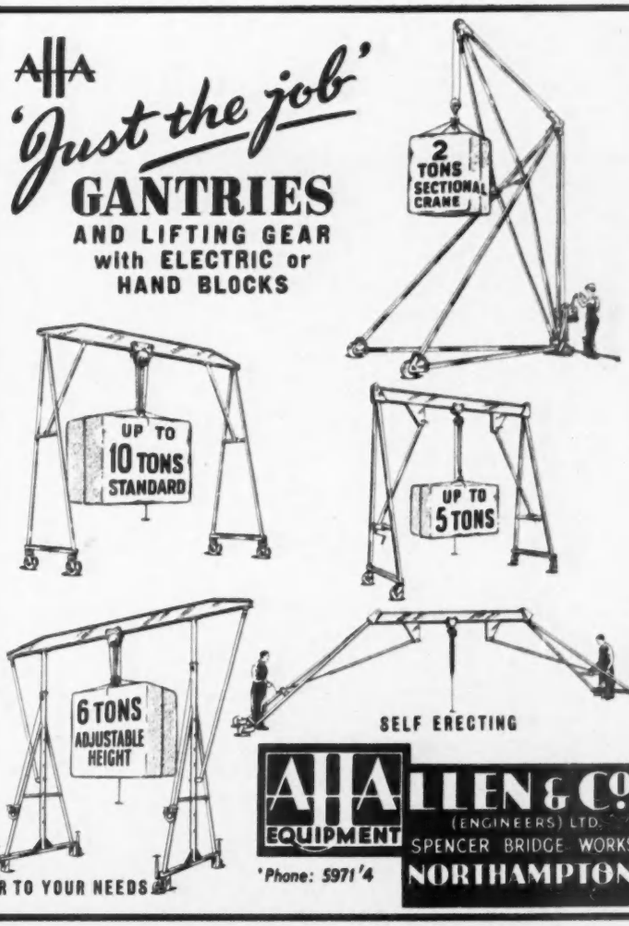

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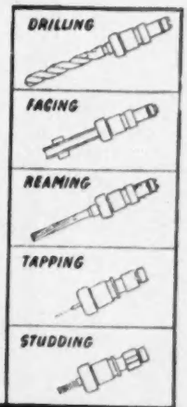
WITH THE NEW 'Jay-Dee' UNIVERSAL ATTACHMENT

you can **INCREASE PRODUCTION** *by* **50%**

Split-second tool changing gives you all operations applicable to the art of drilling!

ONE SETTING IS ALL YOU NEED

The amazing "JAY-DEE" Universal Attachment saves you time, labour and money at every turn! Staying permanently in position, needing no adjustment by the operator, it carries out one perfect job after another, rapidly and safely. The "JAY-DEE" is adaptable to all drilling machines, combination lathes, turning and boring mills, and can readily undertake the duties of any three turret stations.



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A demonstration of the "JAY-DEE" Universal Attachment can be arranged to suit your convenience, at your works.

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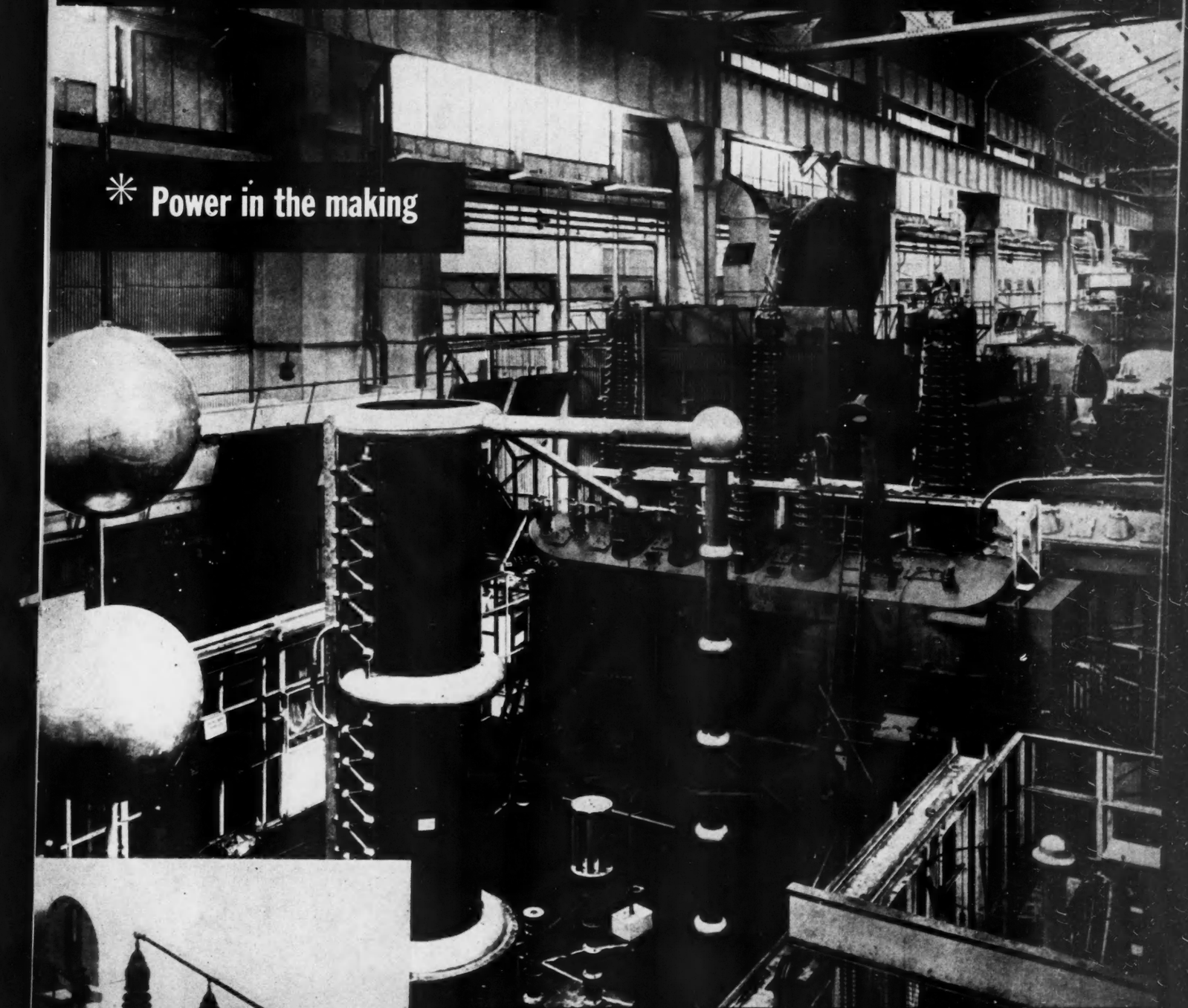

✳ **Power in the making**

The impulse test plant shown here with a 120 MVA transformer on test is rated at 2½ million volts at a stored energy of 60 kW secs.

The autoclave plant behind, used for vacuum drying and oil impregnating processes, is capable of fully enclosing the largest tank yet manufactured by PARSONS.

✳ Transformers have been increased in size over the years to meet the demands dictated by the growth of power systems. Always during this time PARSONS have produced the larger types of transformers. In keeping with these developments PARSONS have installed manufacturing and testing plant to produce power transformers of the highest voltages and ratings.

POWER TRANSFORMERS
TURBO-GENERATORS
CONDENSING PLANT

PARSONS

C. A. PARSONS & CO. LTD.

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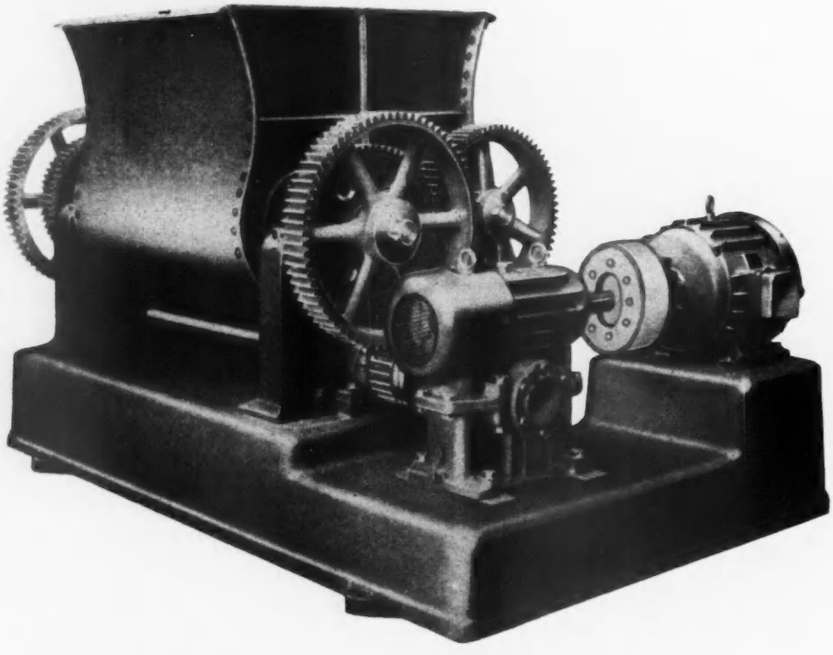
Smooth STARTING

Smooth RUNNING

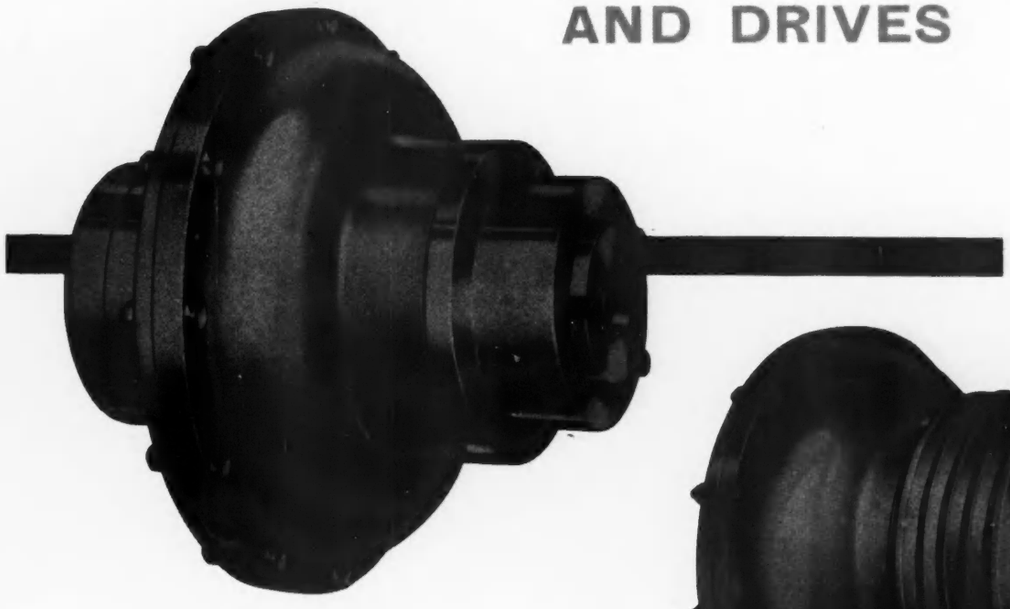


Stallproof power transmission for the most rugged types of machines. This FSC hydraulic coupling makes smooth work of heavy mixing.

Crofts (Engineers) Limited, Thornbury, Bradford 3, Yorkshire

Crofts

'FREE-SPACE' TYPE HYDRAULIC COUPLINGS AND DRIVES



Coupling Type FSC

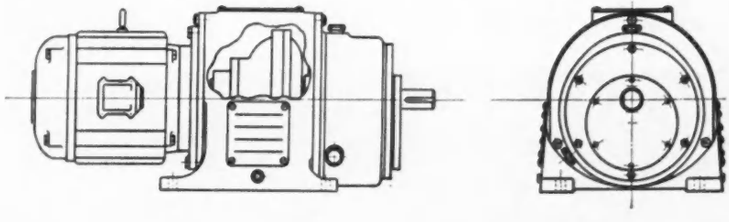
Pulley Type FSP

BRITISH AND WORLD PATENTS PENDING

- **Permit use of smaller, cheaper motors and starters**
- **Provide smooth transmission**
- **Give overload protection for both prime mover and driven machinery**
- **Assure longer machinery life**
- **Range of 15 sizes available for powers fractional to 350 h.p.**
- **Dual types up to 700 h.p.**

EVERY DRIVE IS GUARANTEED—Send for Publication 5814/L

MOTORISED HYDRAULIC 'RITESPEED' DRIVE UNITS



Type FSC Hydraulic Couplings can be supplied in unit form with flange mounted motor and Universal Ritespeed Reduction Gear as illustrated on left.

CROFTS (ENGINEERS) LIMITED

POWER TRANSMISSION ENGINEERS

Head Office : Thornbury, Bradford 3, Yorkshire. Telephone : 65251 (20 lines)

Telegrams : " Crofters Bradford Telex," Telex 51186

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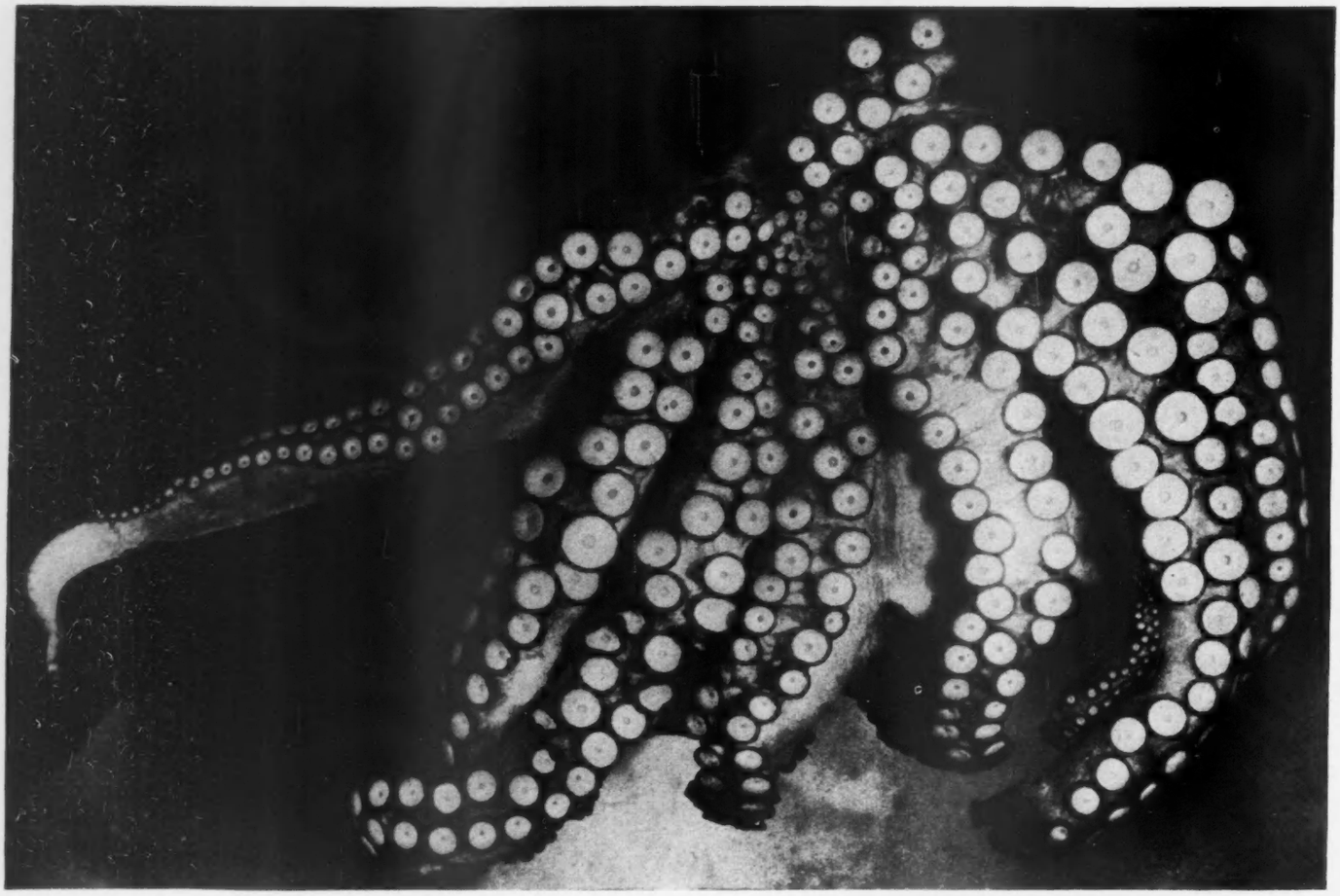

Man-made Octopus

Octopus-like, this KING installation at the Banbury Works of the Northern Aluminium Co. Ltd., handles aluminium slabs 90 ft. long, 7 ft. wide, ¼ inch thick; octopus-like—by tentacles and suction. 44 suction pads are suspended from the lifting beam manifold, each having an automatic cut-off device to prevent loss of vacuum when shorter slabs are required to be lifted. All this is remotely controlled by one operator—yet another example of the superb ingenuity and efficiency of the KING approach.

If you have a problem that needs careful handling—call in KING's—and remember, KING's representatives will call on you anywhere in the world.

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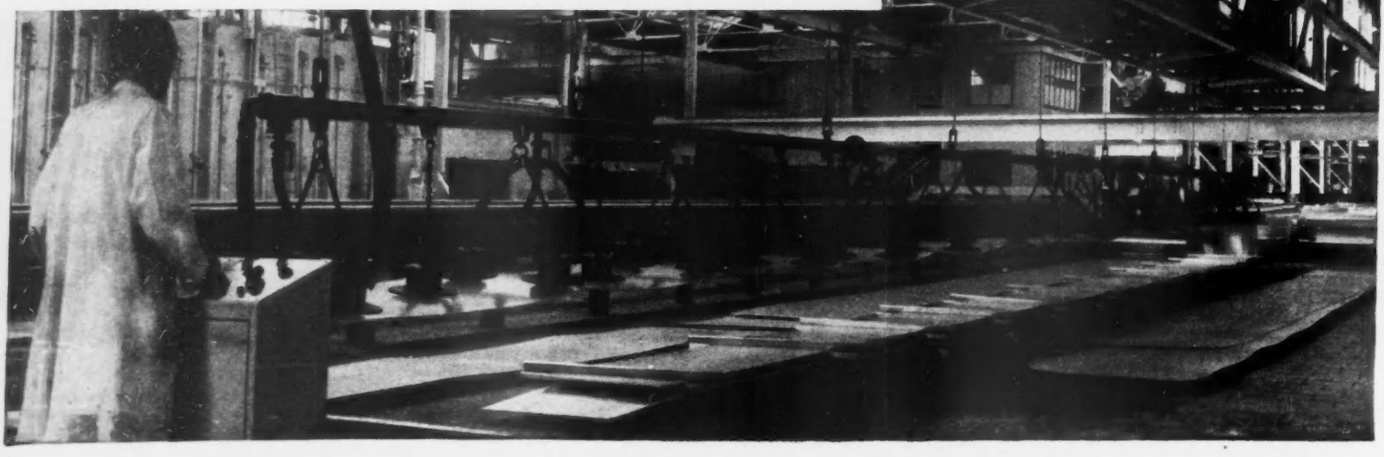

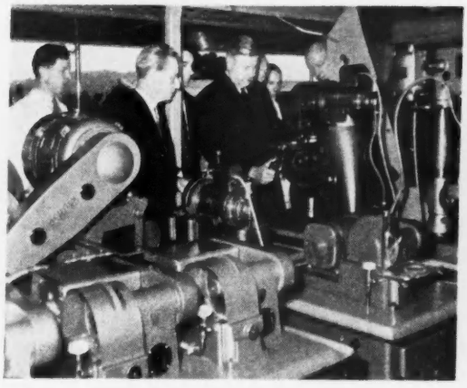

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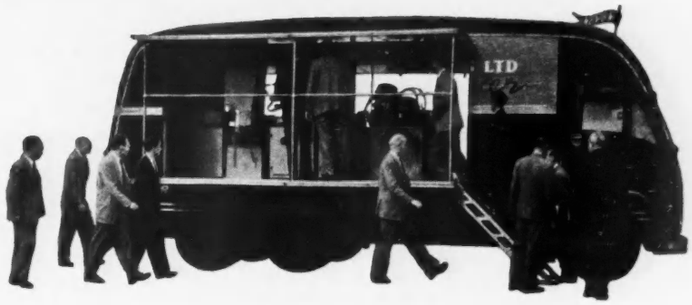

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The NEW PENDEFORD MULTIMETER

LIGHT IN WEIGHT—SIMPLE TO OPERATE—VERSATILE

Make checks in situ at different locations with varying problems, quickly and easily with this new Multimeter. Just plug-in the appropriate transducer, set the 6-position selector switch and read off pressure, tension, load, strain or displacement on the directly calibrated scale. In addition, recording or control can be carried out and the instrument is provided with an electrical output for this purpose.

SPECIFICATION

Energising supply: 5.0 v.; Max. current 200 mA; Frequency 1 Kc/s;
Electrical output ± 0.15 mA full scale into 1,500 ohms load;
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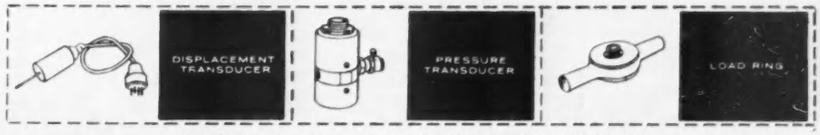
Why not write us for full details of the new Multimeter and our new type transducers? All are specially designed to simplify testing.



Typical transducers for use with the New Pendeford Multimeter.

BPA *electronics*

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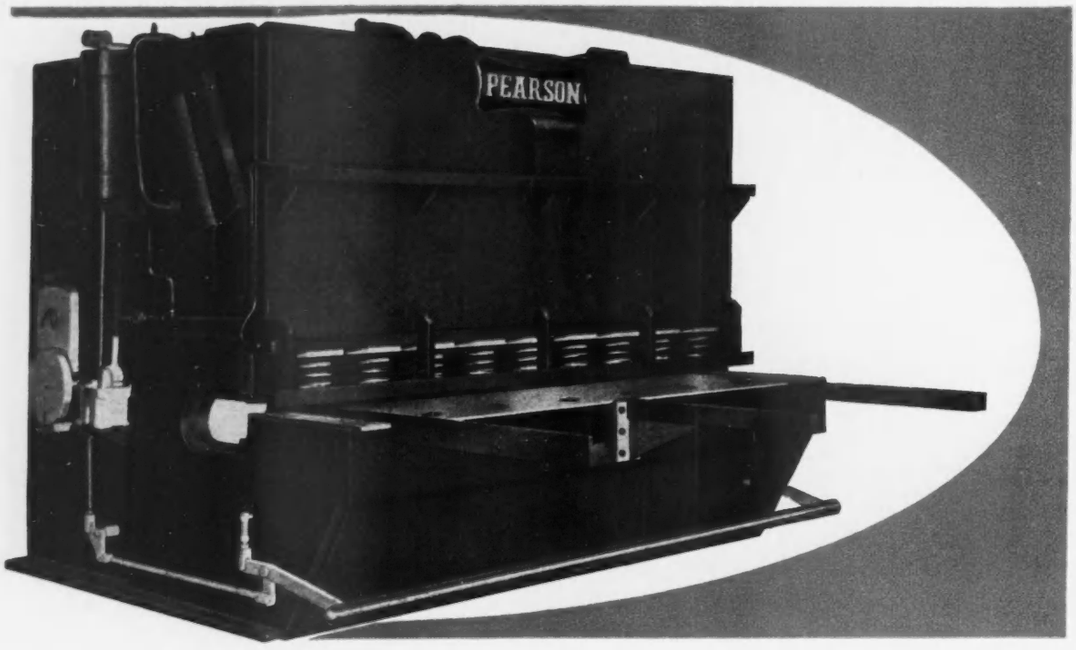

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With the **PEARSON** *Electro-Hydraulic Guillotine*

Simplicity of operation plus automatic safeguard against overloading enable work demanding a high degree of accuracy to be handled with speed and precision by an operator with the minimum amount of skill — factors which, combined with the low running costs of the Pearson Guillotine, make it an asset to productive economy.

- *Designed for perfectly straight and accurate high speed cutting without burrs or marking.*
- *Robustly constructed for service under the most severe working conditions.*
- *Manufactured in all sizes from 6' 0" x $\frac{1}{8}$" to 12' 0" x 1".*
- *For further information you are invited to write for an illustrated catalogue which gives full details.*

PEARSON MACHINE TOOL CO. LTD.
(A subsidiary of T. B. PEARSON & SONS LTD.)

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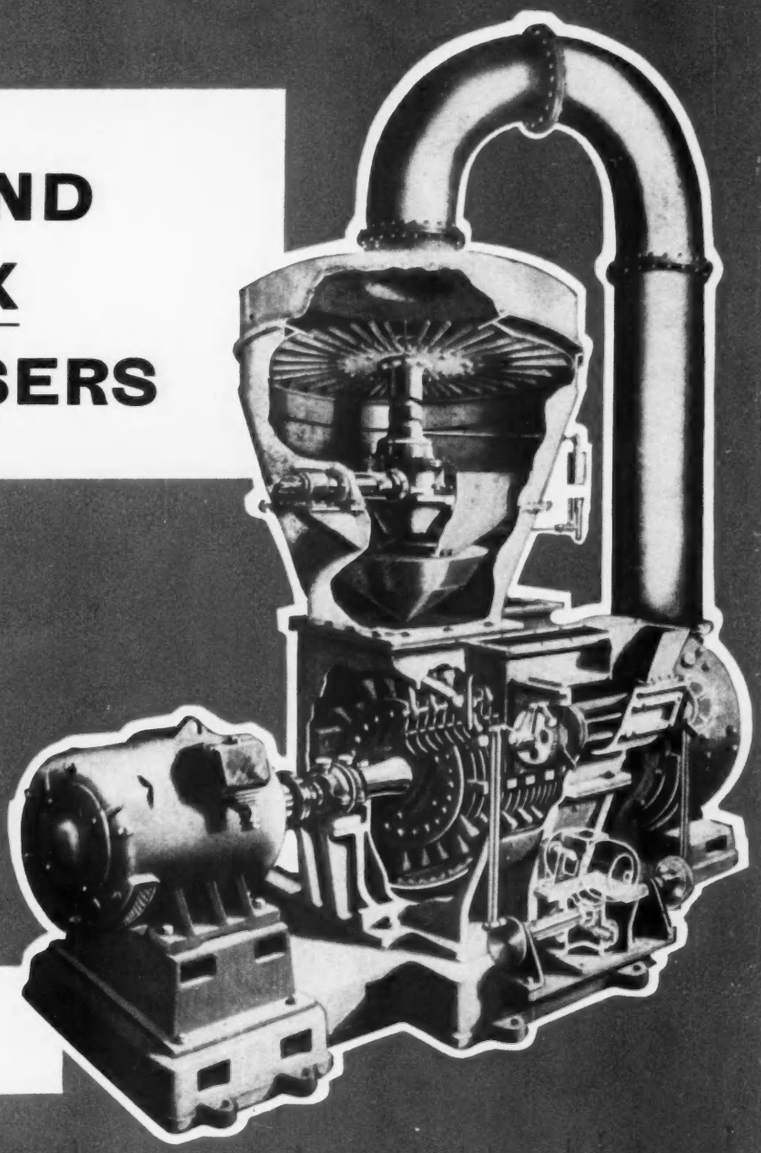
RAYMOND IMPAX PULVERISERS



Sectional view of No. 70 Raymond Impax Pulveriser

Grinding of non-abrasive materials to a guaranteed consistency of fineness is ensured by the range of Raymond Impax Pulverisers.

• Robust design • High-speed manganese steel hammers • Centre shaft supported on ball bearings • All wearing parts simple in design and readily accessible for maintenance • Partial vacuum system gives dustless operation • Easy adjustment for fineness of finished product • System provides for continuous return and re-grinding of oversize particles • Made in a range of sizes.

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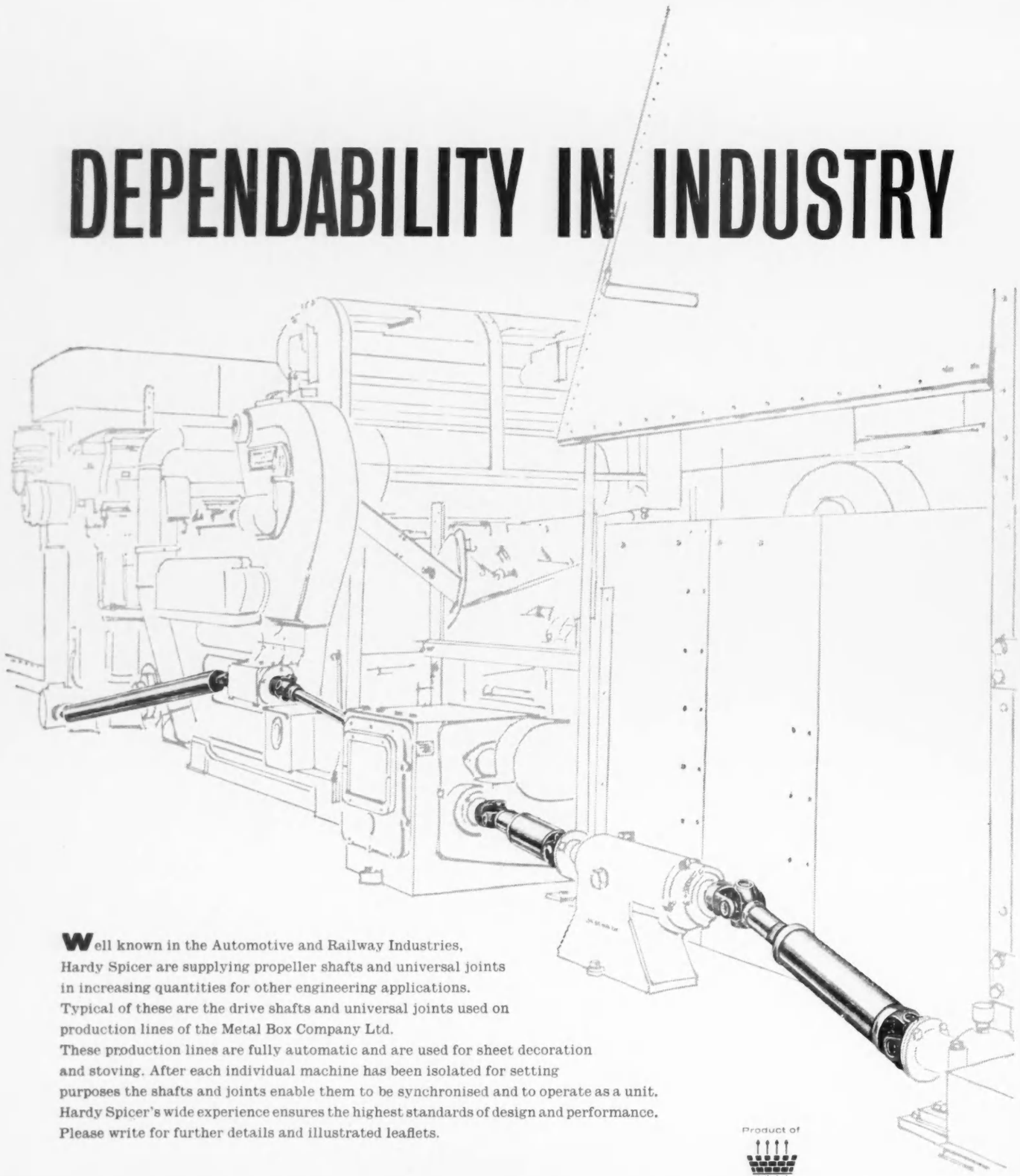

Well known in the Automotive and Railway Industries, Hardy Spicer are supplying propeller shafts and universal joints in increasing quantities for other engineering applications. Typical of these are the drive shafts and universal joints used on production lines of the Metal Box Company Ltd. These production lines are fully automatic and are used for sheet decoration and stoving. After each individual machine has been isolated for setting purposes the shafts and joints enable them to be synchronised and to operate as a unit. Hardy Spicer's wide experience ensures the highest standards of design and performance. Please write for further details and illustrated leaflets.

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HARDY SPICER

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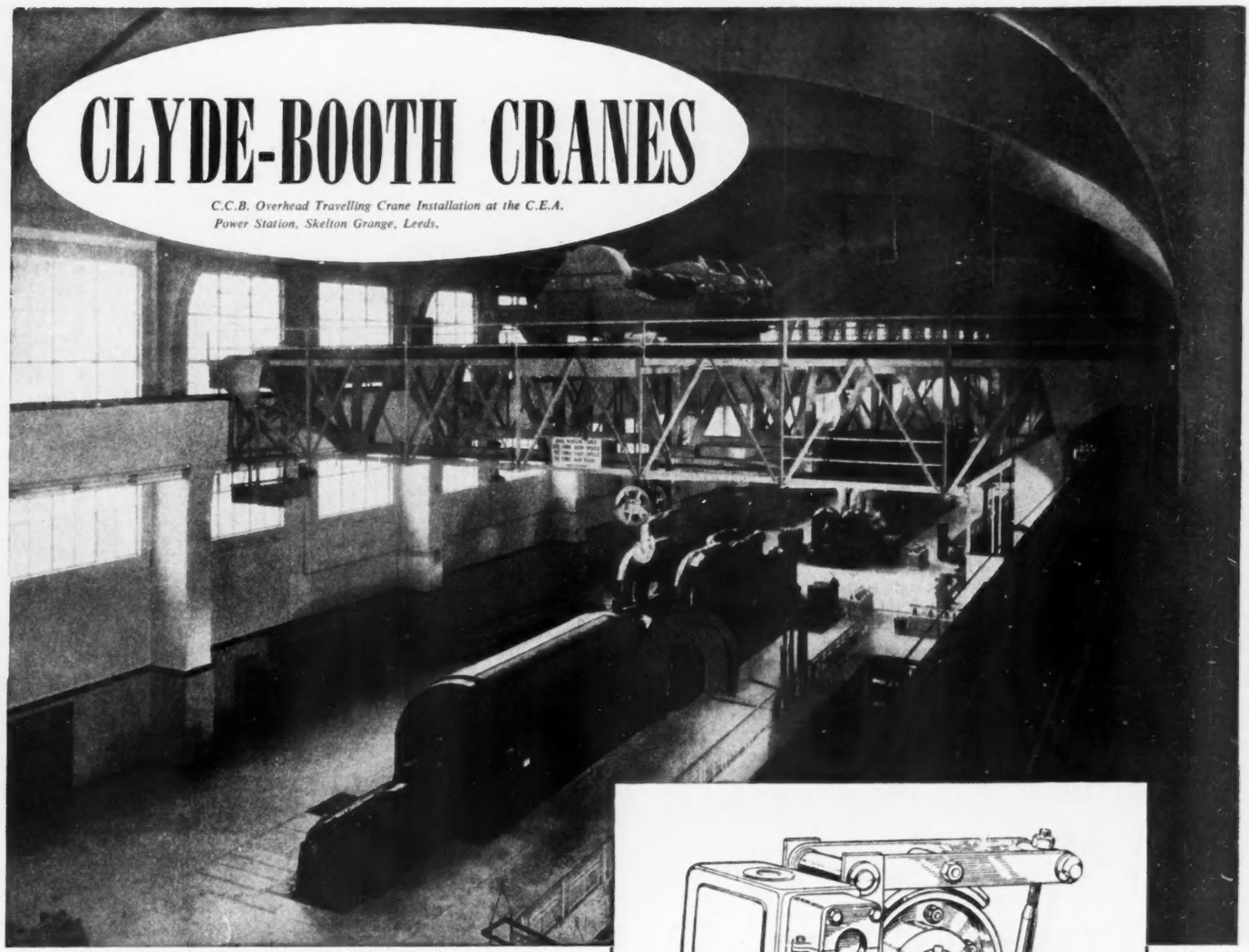

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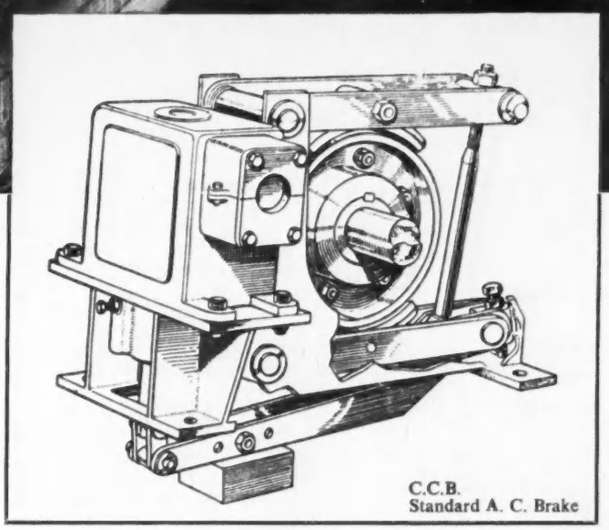

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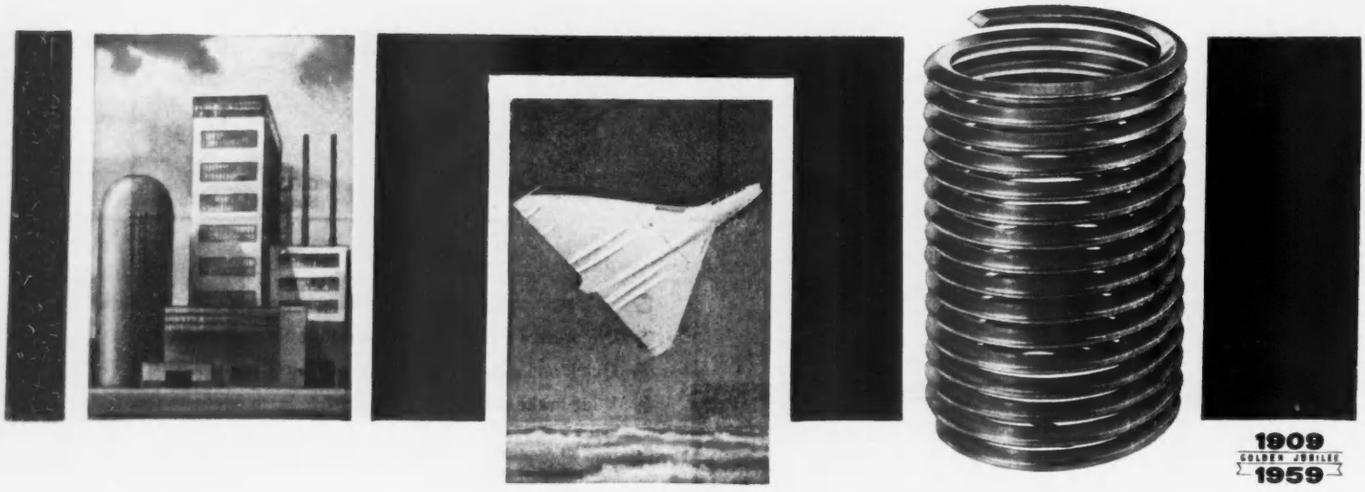

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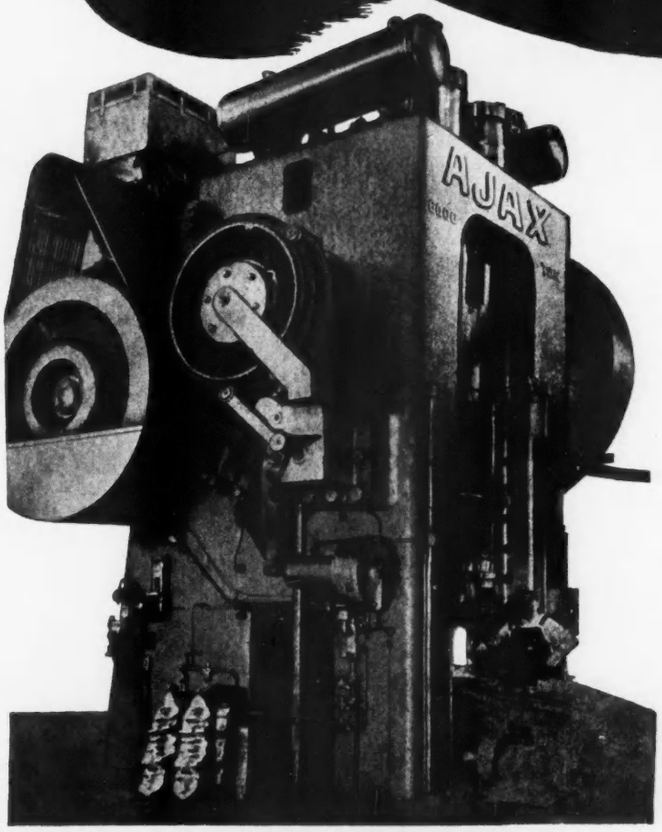

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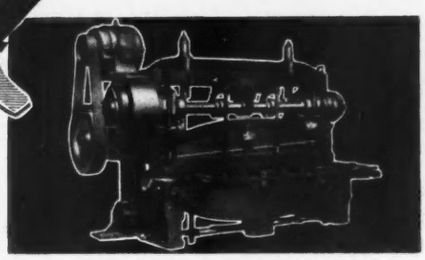

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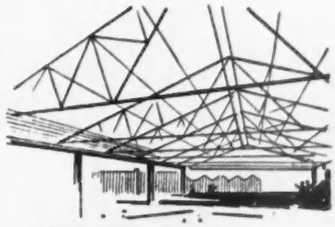

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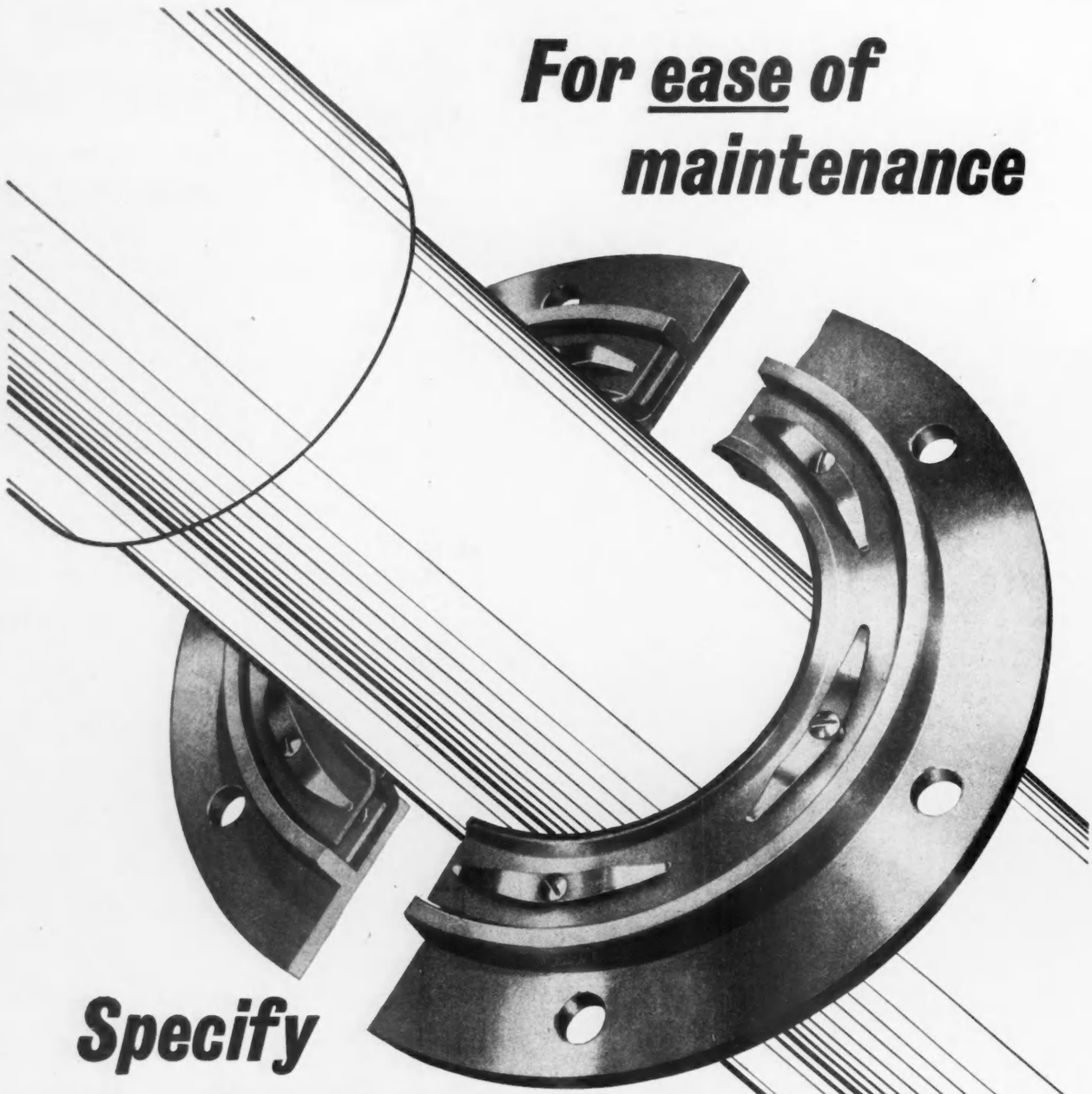

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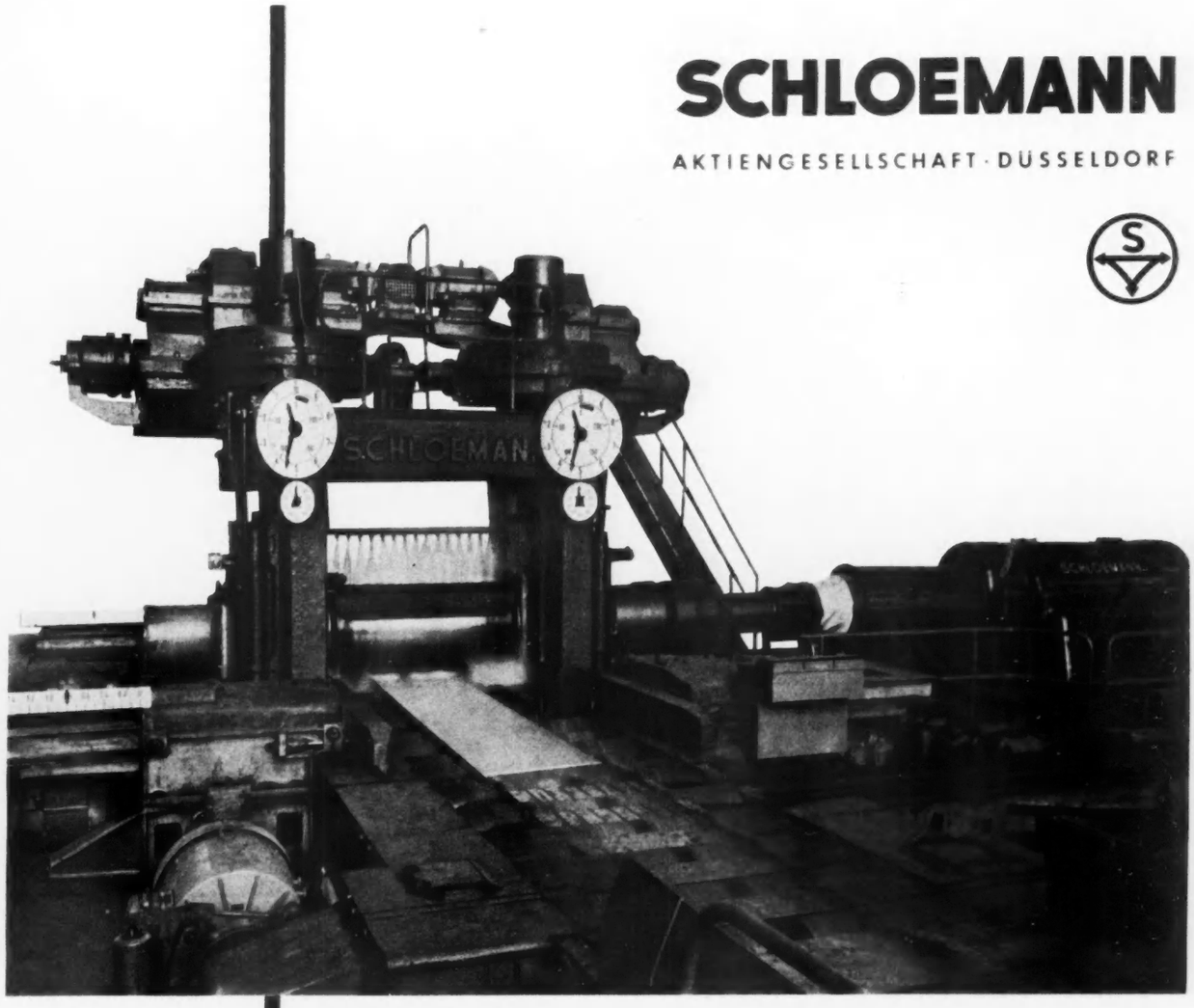

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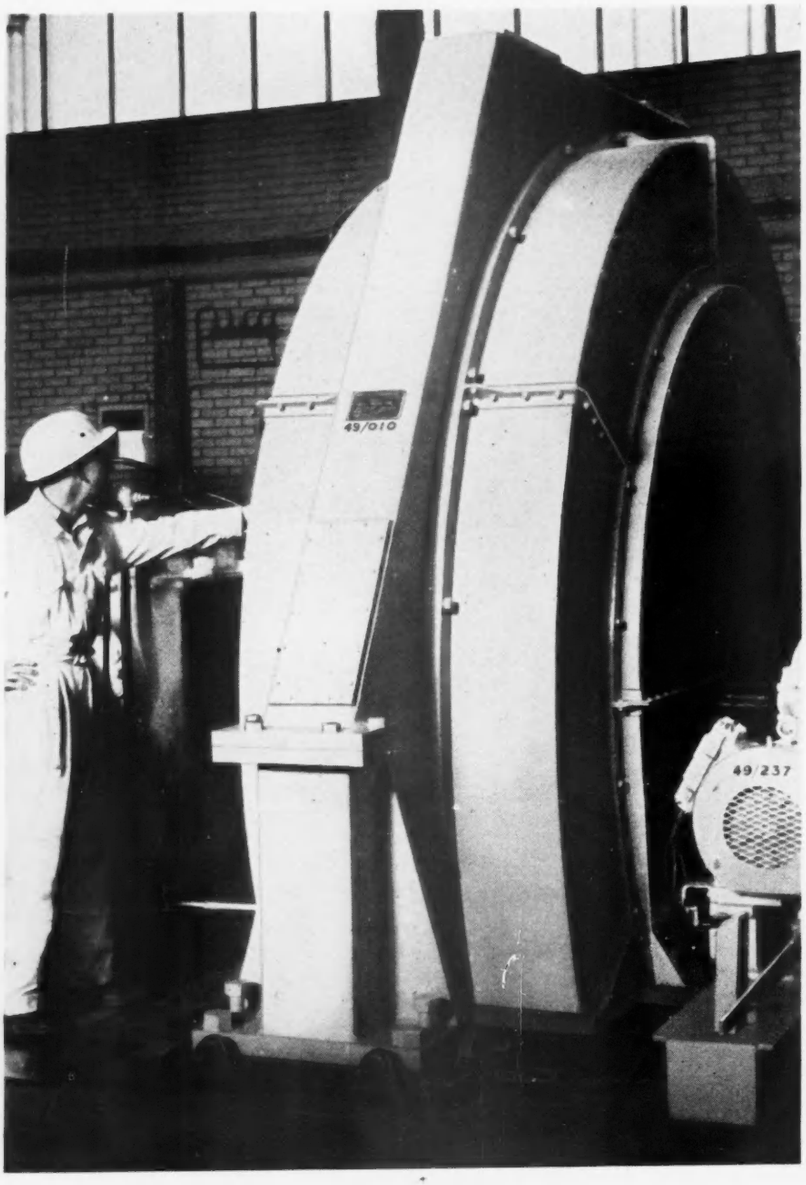

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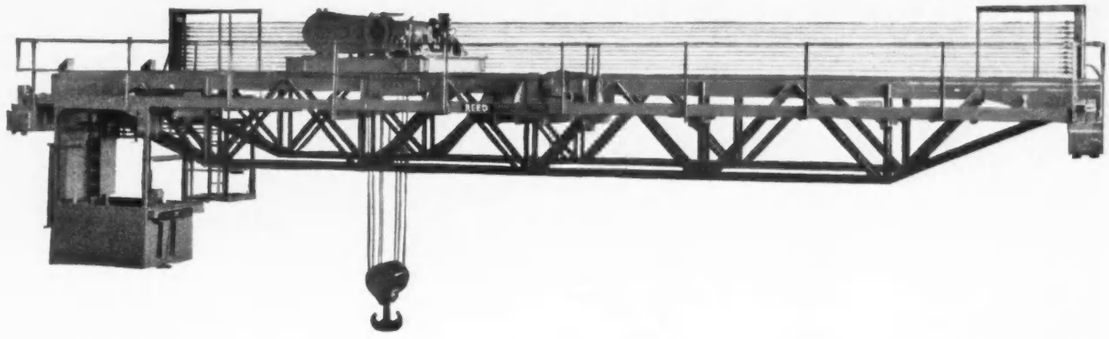

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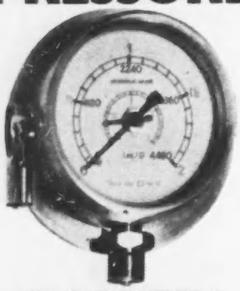

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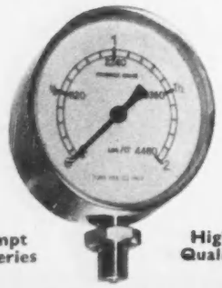

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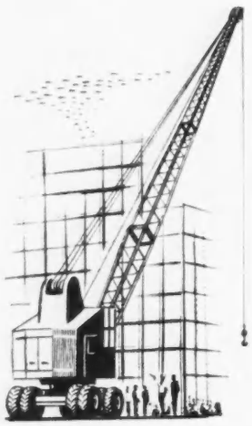

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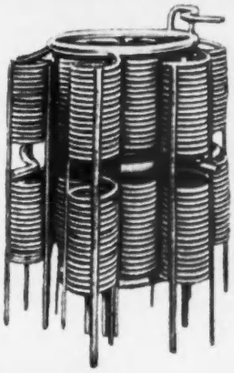

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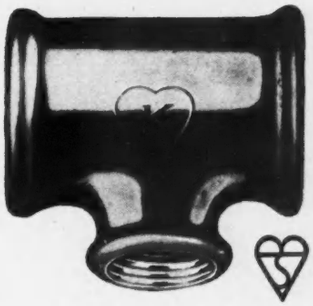

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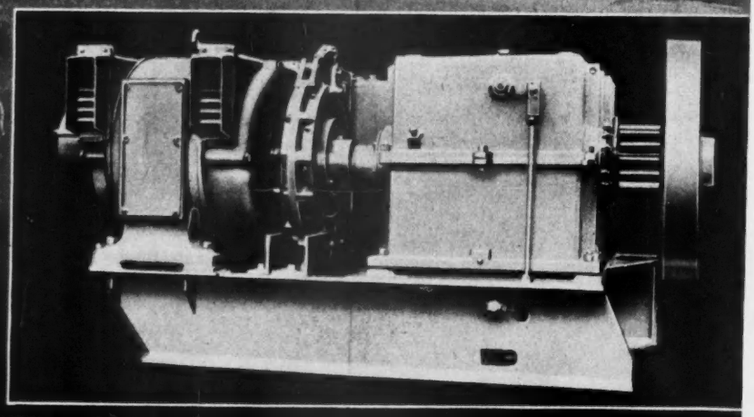

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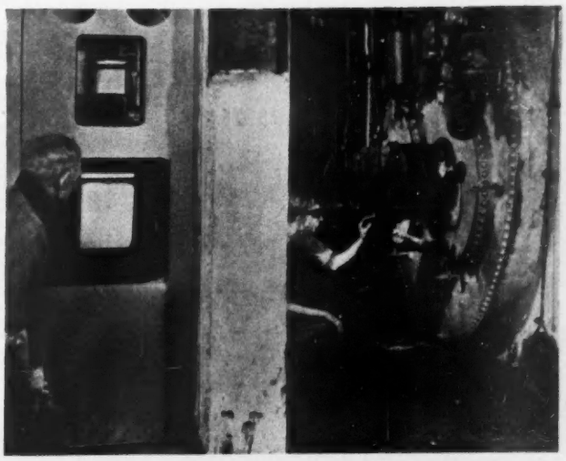

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The recording of flue gas composition in boiler houses large and small is an indispensable aid to fuel efficiency as well as a valuable record to assist compliance with the Clean Air Act. Our picture on the right shows a Cambridge 6 point Electronic Recorder being used to log the CO_2 content of flue gases from six boilers simultaneously (four others are out of the picture). We are grateful to Messrs. Yorkshire Tar Distillers Ltd. for permission to publish this photograph, taken in their boiler house at Kilnhurst.
We illustrate below a selection of specialised applications for the Cambridge Electronic Recorder and acknowledge with thanks the courtesy of the organisations named.

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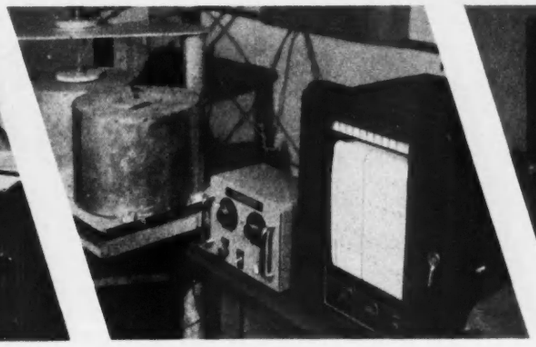

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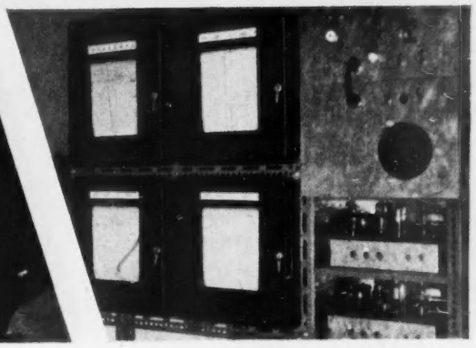

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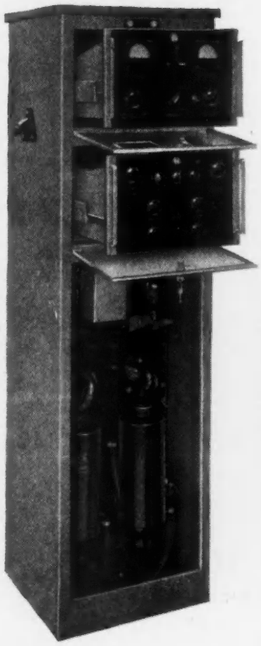

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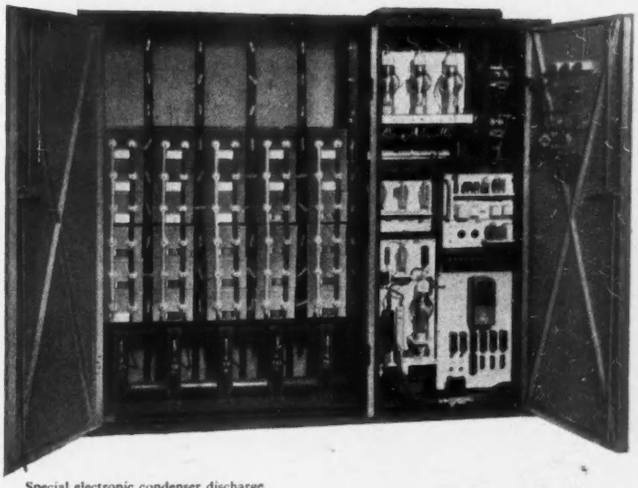

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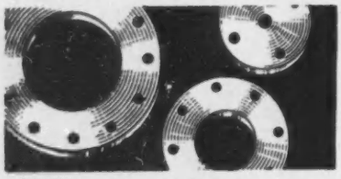

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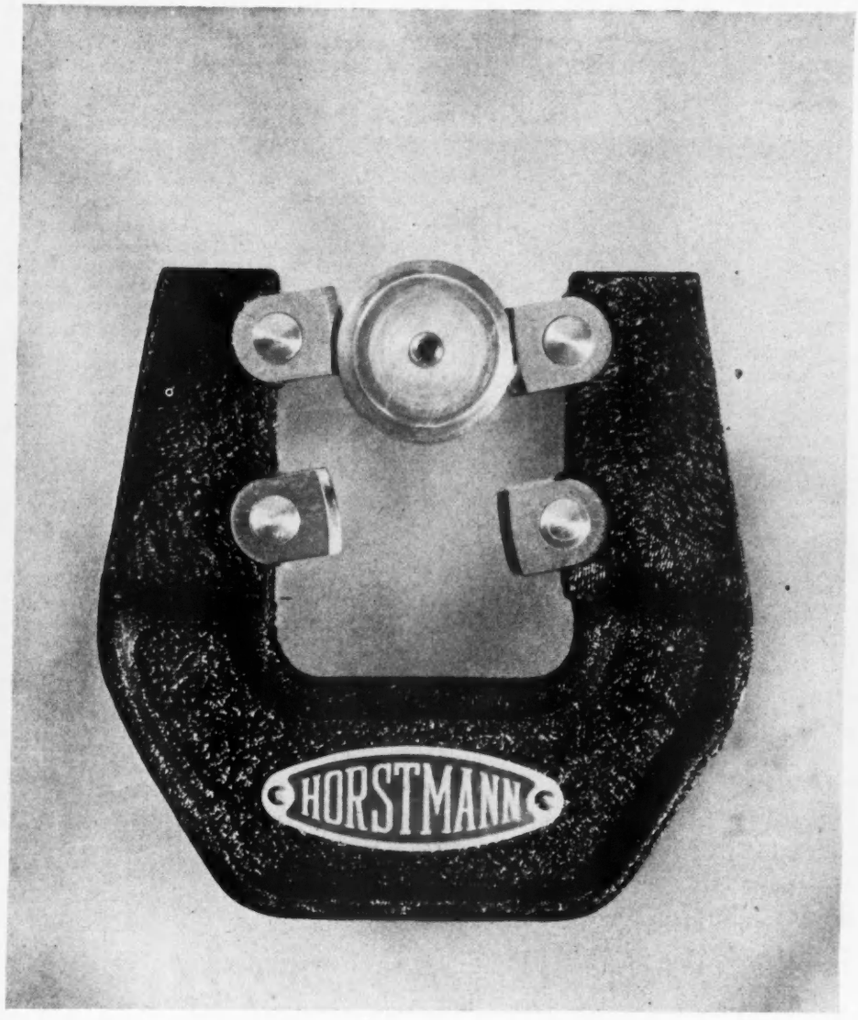

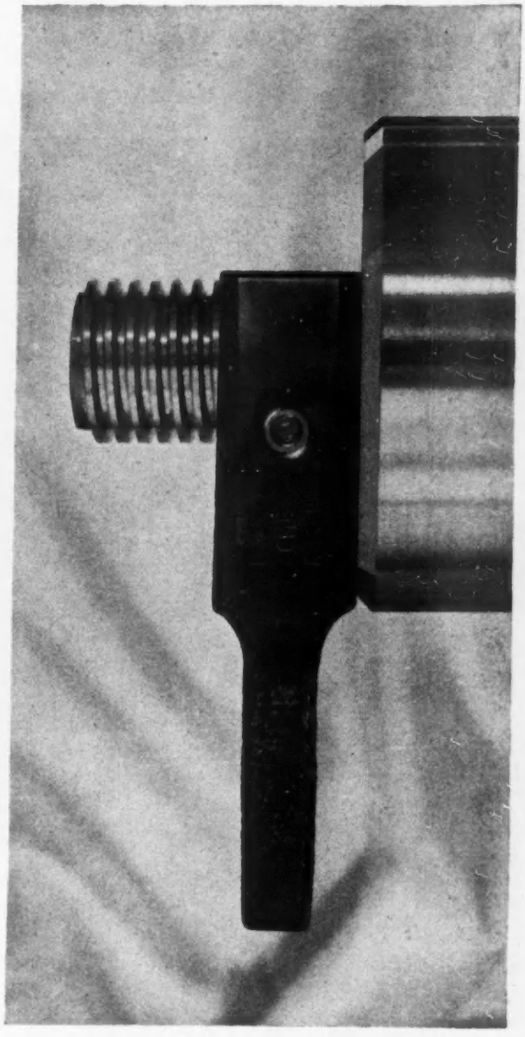

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Inch Rate. 42/- per single column inch and pro rata. 12 lines to 1 inch There are reduced rates (i.e., not on a pro rata basis) for advertisements of ¼-page (12 column inches) and upwards, e.g., ¼-page £22. ½-page £41 10s. Full page £78.

Series Discounts. For advertisements 1 inch and upwards. 6 insertions 5%. 13 insertions 10%. 26 insertions 15%.

Run-On and Semi-Displayed Styles. Both these styles are available for single column width advertisements of any depth up to 12 inches.

Displayed and Illustrated Styles. The minimum size for a Displayed advertisement is 3 inches single column, for an illustrated advertisement it is a ¼-page (12 column inches). Thereafter the sizes for both progress in steps 3 inches deep across 1, 2, 3 or 4 columns.

Use of Box Number. 2/- which includes forwarding of replies.

Copy Dates. "Run-on" and "Semi-displayed" advertisements by noon Tuesday for publication on Friday same week. "Displayed" and "Illustrated" advertisements by noon Friday for publication on following Friday. All advertisements three days earlier if proofs are required.

Advertisements for publication should be addressed to:—**Classified Advertisement Dept., "The Engineer", 28 Essex Street, Strand, London, W.C.2.**

Urgent advertisements may be telephoned to CENtral 6565

PUBLIC APPOINTMENTS

COUNTY BOROUGH OF BRIGHTON EDUCATION COMMITTEE

BRIGHTON TECHNICAL COLLEGE

Principal: G. E. WATTS, M.A., Ph.D. (Cantab.), B.Sc. (Lond.), F.R.I.C.

MECHANICAL ENGINEERING DEPARTMENT

Required as soon as possible:

LECTURER or ASSISTANT (Grade B) in ENGINEERING METALLURGY for degree and diploma courses, prepared to teach at least one other mechanical engineering subject, with Degree in Engineering or Metallurgy or corporate membership of appropriate professional institution.

Salary scales (subject to revision from 1st October, 1959):

LECTURERS (Men): £1260 by £31 10s. to £1417 10s.

ASSISTANTS Grade "B" (men): £682 10s. by £26 5s. to £1076 5s., plus graduate and training allowances if appropriate.

Increments may be allowed in each scale for approved industrial, professional or research experience.

Further particulars and application forms from the undersigned to be returned to the Principal, Brighton Technical College, Brighton, 7, as soon as possible.

W. G. STONE,
Director of Education.

54, Old Steine, Brighton. E7356

DEPARTMENT OF MAIN ROADS

NEW SOUTH WALES, AUSTRALIA

CIVIL ENGINEERS

CIVIL ENGINEERS for Department of Main Roads, New South Wales, Australia.

Applications are invited from Graduates (or Undergraduates in their final year) in Civil Engineering of a recognised British or Irish University for appointment to the staff of the Department of Main Roads, New South Wales, the State Road Authority for construction of roads and bridges.

On appointment, applicants may be engaged at the Department's Head Office, Sydney, on the design of reinforced concrete and steel bridges, or on main road construction and maintenance either in the Metropolitan Area or the country.

Commencing salary according to qualifications and experience, will be within the range £A1185 to £A1410 per annum, with annual progression, subject to technical competence, to £A2095 per annum. Appointees will be eligible to contribute to the State Superannuation Fund after six months.

Appointee's full fare from England to Australia will be met by the Department, subject to a three years' service guarantee bond being completed. Appointment will be subject to passing a medical examination and preference will be given to applicants not more than 30 years of age.

Applications should be made on forms obtainable from the Agent General for New South Wales, 56, Strand, London, W.C.2. E7380

DEPARTMENT OF SCIENTIFIC AND INDUSTRIAL RESEARCH

NATIONAL ENGINEERING LABORATORY, EAST KILBRIDE, GLASGOW

PRINCIPAL SCIENTIFIC OFFICER

Pensionable post at National Engineering Laboratory, East Kilbride, Glasgow for ENGINEER or PHYSICIST (man or woman) to take charge of fundamental research on cutting. Qualifications normally first or second class honours degree in a scientific subject (including Engineering), or high professional attainment. Research experience on cutting, or in plasticity, friction, or vibration essential. Industrial experience an advantage. Salary scale (men) £1420–£2020. Starting pay may be above minimum. Good housing prospects.—Write Civil Service Commission, 17, North Audley Street, London, W.1, for application form, quoting S4986/59. Closing date 23rd October, 1959. E7355

PUBLIC APPOINTMENTS

UNIVERSITY OF GLASGOW

MECHANICAL AND ELECTRICAL ENGINEERS

The University of Glasgow, with the support of the Nuffield Provincial Hospitals Trust, will shortly establish a small Research Unit to study certain engineering problems which arise in connection with the construction and maintenance of hospital buildings. The provision of specifically engineering services accounts for an increasing proportion of hospital costs, and experience has disclosed a considerable variation in the degree of success of these services. The assignment is expected to occupy two years in the first instance, with a possible extension.

The University wishes to appoint MECHANICAL and ELECTRICAL ENGINEERS to this Unit, and invites applications from candidates with good academic and professional qualifications. The appointments will be in two grades with salary ranges of £1300–£1500 per annum and £1500–£1800 per annum respectively, together with necessary travel and other expenses. Further particulars may be obtained from the Secretary of the University Court, The University, Glasgow, W.2.

E7296 ROBT. T. HUTCHESON, Secretary of University Court.

NORTH RIDING EDUCATION COMMITTEE

CLEVELAND TECHNICAL COLLEGE, REDCAR

ASSISTANT, GRADE B

Applications are invited for the post of ASSISTANT, GRADE B for practical subjects in Machine Shop and Craft Practice Courses.

Forms and particulars available from me on receipt of stamped, addressed envelope. Completed forms to be returned by 2nd October, 1959.

F. BARRACLOUGH.

County Hall, Northallerton. E7374

CIVIL SERVICE COMMISSION

INLAND REVENUE

VALUERS

Pensionable posts for qualified men and women in Valuation Offices in England and Wales and in Scotland. Vacancies are in District (Revenue and Compensation) and Area (Rating) offices and include posts for valuation of minerals, plant and machinery, and licensed property. Vacancies in Scotland are in District (Revenue and Compensation) offices only. Posts in 2nd or 3rd Class for valuation of minerals, others in 3rd Class. Age at least 25 on 1st October, 1959 and under 34 for posts in 3rd class or under 50 for posts in 2nd class. Extension for regular Forces service and Overseas Civil Service. Qualifications: (a) Corporate Membership of R.I.C.S., C.A. and E.A.I., or C.L.A.S. and (b) Final Examination for one of the bodies in (a), or appropriate University degree (e.g. B.A. (Cantab.) or B.Sc. (Lond.) in Estate Management). At least 4 years' professional (or mining, for valuation of mineral posts) experience. For Scottish posts experience in Scotland desirable, and qualifying examination preferably based on Scottish syllabus. For valuation of minerals, posts, 1st Class Certificate of Competency (Mine Managers) acceptable as professional qualifications. Starting salary (men, London): 3rd Class from £830 (25) to £1125 (34 or over); scale maximum £1300. 2nd Class scale £1325–£1835. Promotion prospects.—Write Civil Service Commission, Burlington Gardens, London, W.1, for application form quoting 148-149/59. Closing date 20th October, 1959. E7348

BRITISH RAILWAYS

LONDON MIDLAND REGION

STRUCTURAL DESIGNERS

Structural Designers with some experience in design and detail of steel and concrete bridges required in the Bridge Section of the Chief Civil Engineer's Office, Euston Station.

Salary £833 to £985 per annum according to experience. Good prospects for men of ability and initiative. Five-day week. Residential travel and other travelling facilities available. Superannuation scheme.

Applications giving details of experience should be addressed to the Chief Civil Engineer (Reference No. 85), British Railways, London Midland Region, 5a, Euston Grove, London, N.W.1. E7334

PUBLIC APPOINTMENTS

REPUBLIC OF THE SUDAN

SUDAN GEZIRA BOARD

APPOINTMENTS

Applications are invited from those suitably qualified to fill the following vacancies in the Sudan Gezira Board:

(a) ASSISTANT ELECTRICAL ENGINEER, Ref. 4/2415; and

(b) ENGINEER, GINNING FACTORIES, Ref. 4/2420.

Qualifications: (a) Candidates must have served a recognised course of training in electrical engineering and have had subsequent experience in supervising skilled men in maintenance and installation work. Possession of H.N.C. is desirable. (b) Candidates must have served a recognised course of training in engineering and have had several years' experience in maintenance of electric motor-driven textile plant, hydraulic equipment, fans, &c. Possession of the H.N.C. or equivalent an advantage.

Duties: Post (a). To be responsible to the Electrical Engineer and act as his Deputy. The work entails H.V. sub-stations, a.c. and d.c. industrial Motors and Starters. L.V. distribution and domestic installation. Post (b). Responsible to the Manager for the maintenance of the general engineering equipment in several ginning sheds at one of Board's factories.

Terms of service: The appointment will be on Contract for a period of three years, in the salary range £S.1000 to £S.1500. A gratuity of one-fifth of the total fixed salary will be paid on satisfactory completion of period of service. A cost of living allowance is payable; this is reviewed quarterly. An initial outfit allowance of £S.60 is paid on appointment. Housing, including garden, light and water will be provided free by the Board. Leave of 60 days with passage allowance is provided annually. There is no income tax payable in the Sudan at present. Applications in writing, stating age, qualifications and experience should be made to Personnel Section, Sudan Embassy, Cleveland Row, St. James's, London, S.W.1. Closing date 10th October, 1959. E7378

ROYAL NAVAL SCIENTIFIC SERVICE

SENIOR SCIENTIFIC OFFICERS AND SCIENTIFIC OFFICERS

Vacancies for SENIOR SCIENTIFIC OFFICERS and SCIENTIFIC OFFICERS in following localities:

LONDON AREA: MECHANICAL ENGINEER with sound knowledge of basic principles of thermo and fluid dynamics to carry out research programme in a particular field of applied hydrodynamics. Experience in modern methods of design and research on axial flow compressors, turbines or pumps an advantage. MECHANICAL ENGINEER for work on propulsion problems. APPLIED MATHEMATICIAN for research of basic nature on stability of underwater vehicles: knowledge of theoretical hydrodynamics and theory of control systems an advantage. APPLIED MATHEMATICIAN or THEORETICAL PHYSICISTS for acoustic analysis. ELECTRONIC PHYSICISTS for data handling and analysis problems. PHYSICIST interested in operator performance. CLASSICAL PHYSICISTS.

BALDOCK: PHYSICISTS or APPLIED MATHEMATICIANS for research in Metal or Quantum Physics.

PORTSMOUTH: ELECTRONIC ENGINEERS for research on analogue computers and transistor circuits. ELECTRICAL ENGINEERS for research on small rotating electrical machinery. PHYSICISTS—for optical systems and instrumentation. ELECTRO-MECHANICAL ENGINEERS — for work on servo-mechanisms.

PORTLAND: PHYSICISTS or APPLIED MATHEMATICIANS for research on underwater acoustics. ELECTRONIC PHYSICISTS, ELECTRONIC ENGINEERS—for design work. PHYSICAL CHEMISTS.

POOLE: CHEMICAL ENGINEERS. CHEMISTS for work on rubber technology.

ROSYTH: PHYSICISTS—(Electronic).

Candidates must normally be natural born British subjects of natural born British parents, with First or Second Class Hons. Degrees, S.S.Os. must have had three years' post-graduate experience and be not less than 26 years of age. Salaries (men): S.S.O., £1233–£1460; S.O., £655–£1150 (London), somewhat lower in provinces. Appointments unestablished (with F.S.S.U. benefits), but opportunities may occur for those between ages of 21 and 32 to compete for established posts.

Forms from M.L.N.S., Technical and Scientific Register (K), 26, King Street, London, S.W.1 (quote A.220/9A). E7037

PUBLIC APPOINTMENTS

NORTH EAST METROPOLITAN REGIONAL HOSPITAL BOARD,

40, EASTBOURNE TERRACE, LONDON, W.2.

EXPANSION OF ENGINEERING SECTION

The Region comprises East London, the majority of the County of Essex and parts of the Counties of Middlesex and Hertfordshire, with over 140 hospitals, clinics, &c., and the Board occupy modern offices adjacent to Paddington Station. The Board are engaged in an expanding programme of hospital development, including new hospitals, replanning of existing hospitals, the provision of outpatients' departments, operating theatres, laboratories, nurses' homes, staff homes, occupational therapy centres, patients' accommodation, &c., by new building or by converting and extending existing buildings, and the undermentioned appointments offer particularly valuable experience in planning and supervising the installation of large-scale heating and hot-water systems, conversion of boilers to oil-firing, ventilation of operating theatres, engineering services and equipment for laundries and kitchens.

Own car may be used for visiting hospitals, &c., for which adequate mileage allowance paid. Posts pensionable and prospects of advancement good. New entrants to the hospital service will be placed at the bottom of the appropriate scale, except in the case of assistants, where salary may be advanced beyond the minimum for those over 23 with appropriate professional experience. Previous hospital experience is not essential. All salary scales now being reviewed.

PRINCIPAL ASSISTANT ENGINEER (Mechanical)

Salary: £1245–£1470. Applicants must be Corporate Members of the Institution of Mechanical Engineers, unless professionally graded in the National Health Service, and should possess experience in a senior capacity in the design of boiler plants, steam, heating, hot water and ventilating systems, and have a sound knowledge of all associated mechanical equipment. The successful candidate will be required to control the work of a substantial engineering staff.

SENIOR ASSISTANT ENGINEERS (Mechanical/Heating and Ventilating)

Salary: £1100–£1295. Applicants must be Corporate Members of the Institution of Mechanical Engineers, unless professionally graded in the National Health Service, and should possess experience in a senior capacity in the design of boiler plants, steam, heating, hot water and ventilating systems and have a good knowledge of all associated mechanical equipment.

ASSISTANT ENGINEERS (Mechanical/Heating and Ventilating)

Salary according to age and experience, up to a maximum of £1105. Applicants must be Graduate Members of the Institution of Heating and Ventilating Engineers and have passed the Associate Membership examination or hold exempting qualifications. The posts offer opportunities to cover the whole field of heating, ventilating and mechanical engineering in hospitals.

ENGINEERING ASSISTANTS, GRADE I

Salary: £700 (at age 23) to £1055. Applicants must hold the Higher National Diploma or Certificate in Mechanical Engineering, a recognised Engineering Degree, or their equivalent.

Applications, giving age, present salary, qualifications and experience (with dates), together with the names of three referees, to the Secretary, North East Metropolitan Regional Hospital Board, 40, Eastbourne Terrace, London, W.2, within 14 days. E7363

WEY VALLEY WATER COMPANY

CIVIL ENGINEERING ASSISTANT

CIVIL ENGINEERING ASSISTANT, commencing salary £750–£850 per annum, with annual increments, plus car allowance.

Applications are invited for the above appointment on the permanent staff of the Wey Valley Water Company.

Qualifications: applicants must have been trained as civil engineers and have either passed Parts I and II of the Institution of Civil Engineers' examination or hold a University Degree. Preference will be given to those who have had experience in the office of a water engineer.

The applicant should hold a licence to drive a car.

The appointment is permanent and pensionable.

Applications, stating age, qualifications, present position and salary, and giving an account of his education, training and experience, should be sent to the Engineer and Works' Manager, Wey Valley Water Company, 3, Downing Street, Farnham, Surrey, not later than 30th September, 1959. E7243

Classified Advts. continued on page 152

PUBLIC APPOINTMENTS

THE ROYAL COLLEGE OF SCIENCE AND TECHNOLOGY GLASGOW

(In affiliation with the University)

DEPARTMENT OF MECHANICAL CIVIL AND CHEMICAL ENGINEERING

RESEARCH ASSISTANTS are required in Mechanical Engineering for work in connection with various industrial research investigations. Excellent opportunities exist for suitably qualified candidates to read for higher degrees.

Salary in the range £500–£750 per annum.

Application forms are available from the College Secretary.

E7366

TENDERS

GOVERNMENT OF NEW ZEALAND

MINISTRY OF WORKS
WAIRAKEI GEOTHERMAL PROJECT
PILOT HOT WATER SCHEME

FLASH STEAM PLANT

TENDERS will shortly be invited for the SUPPLY and ERECTION of a FLASH STEAM PLANT to produce 200,000 lb./hr. of steam at 50 p.s.i.g. and 200,000 lb/hr. of steam at 3 p.s.i.g. from 12 cusecs of hot water at 380 deg. Fah. The plant includes 6 pressure vessels of 54in. diameter by 19ft., two vessels 72in. diameter by 17ft., pipework up to 66in. diameter, with valves, associated equipment and structural supporting steelwork.

Interested firms should apply to Merz and McLellan, Milburn, Esher, Surrey, for full particulars. No further announcement will appear in the Press and manufacturers should regard this notice as the formal invitation to tender. E7346

GOVERNMENT OF HONG KONG

SHEK PIK WATER SCHEME

LAYING TWIN SUBMARINE PIPELINES

The Government of Hong Kong invites TENDERS from Contractors with experience of laying submarine pipelines for the LAYING of TWO 30 inch diameter STEEL PIPELINES to carry filtered water from Lan Tao Island to Hong Kong.

The main items of the works are :—

(a) Welding, Bitumen Sheafing and Concrete Cladding of the pipes which are supplied by the Government of Hong Kong.

(b) Laying the pipes as twin pipelines each about 8 miles long, and burying them below the sea bed.

The contract documents can be inspected at the office of the undersigned and can be obtained from them on payment of twenty-five pounds during the period 2nd November, 1959, to 1st February, 1960—the deposit to be refunded on receipt of a bona fide Tender.

Sealed Tenders, endorsed "Tender for Shek Pik Submarine Pipeline" and addressed to the Chairman of the Tender Board, Colonial Secretariat, Lower Albert Road, Hong Kong, must be delivered to the above address by noon on 1st June, 1960.

Tenderers are warned that the fair weather season which is suitable for site investigation is limited to the period beginning in November and ending in May.

The Government of Hong Kong does not undertake to accept the lowest or any Tender, nor will expenses in connection with Tendering be defrayed, but Tenderers must make themselves fully acquainted with the site and conditions of work.

BINNIE, DEACON AND GOURLEY,
Artillery House,
Artillery Row,
Westminster,
London, S.W.1. E7381

EDUCATIONAL

COLLEGE OF AERONAUTICS

A SHORT COURSE ON
AIRCRAFT GAS TURBINE THEORY AND DESIGN
will be held at the College from Monday, 2nd November, to Friday, 20th November, 1959.

The Course will deal mainly with performance, systems, turbo-machine aerodynamics and related design topics, but will include some experimental work on engines.

Fees for the course are £70, inclusive of full board and residence.

Further details and copies of the syllabus may be obtained on application to The Warden, The College of Aeronautics, Cranfield, Bletchley, Bucks. E7176 E

EDUCATIONAL

A.M.I.MECH.E., B.Sc., City and Guilds, &c. Guarantee Postal Courses for all Exams. and Technical Divisions from Elementary to Degree standard including Automation Techniques. Approximately 95 per cent. successes. 148-page prospectus free on request.—B.I.E.T. (Dept. 22), 29, Wright's Lane, London, W.8. E114 E

SITUATIONS VACANT

APPLICANTS ARE ADVISED TO SEND COPIES NOT ORIGINALS OF THEIR TESTIMONIALS UNLESS OTHERWISE REQUESTED.

AIR TREATMENT ENGINEER required for group of mills near Manchester. Applicants should be capable of preparing schemes and estimates for new plants, and supervising erection and maintenance. Please state experience, technical qualifications and age.—BOX No. E7311, "The Engineer." A

ASSISTANT ENGINEER required for Chemical and Metallurgical Works. The appointment would have in view early promotion of suitable candidate to take charge of Pipe Services Department, with responsibility for maintenance and design of steam producer gas, compressed air and water distribution services, heating, ventilating and process cooling installations. Minimum qualification H.N.C. Age 25–35.—Application to Chief Engineer, Murex, Ltd., Rainham, Essex. E2539 A

ASSISTANT WORKS ENGINEER required. Technical training to H.N.C. standard. Chemical works experience essential. Applicants should be over 26 years of age. Salary according to experience. Pension scheme.—Apply, stating experience and qualifications, to : Personnel Manager, Howards of Ilford, Limited, Ilford, Essex. E7365 A

BRITISH INDUSTRIAL SAND, LTD., High Street, Godstone, Surrey. DRAUGHTSMEN required by rapidly expanding Quarrying Organisation, O.N.C. or H.N.C. Mechanical Engineering an advantage, for work on mechanical handling, conveying plant, structures, &c. Site visiting would be included in duties. Excellent prospects for the right men. There is a Staff Pension Scheme in operation. E161 A

COMPETENT DRAUGHTSMAN, conversant with quarry plants, sound knowledge of structural steelwork. Interesting and varied work, opportunity for site visits, &c.—Roads Reconstruction (1934), Ltd., Engineering Department, Cranmore, Nr. Shepton Mallet, Somerset. E2536 A

DESIGN ENGINEERS AND DRAUGHTSMEN/ELECTRICAL.—Consulting engineers, handling a variety of design projects have vacancies for various grades of Electrical Designers and Draughtsmen. Pension scheme and three weeks' annual holiday after qualifying periods.—Norris Brothers, Limited, 62, Church Road, Burgess Hill, Sussex. E7284 A

DESIGN ENGINEER required in an expanding Technical department dealing with marine reduction gears and V.P. propellers. Good salary for experienced man with right technical background. Pension scheme. Applications to the Technical Manager, giving full details of education, qualifications, age, experience and present salary.—MODERN WHEEL DRIVE, LTD., Lindo Lodge, Chesham, Bucks. E7276 A

DEVELOPMENT ENGINEER required by London Engineering Company for the development of Rear Axles, Differentials and Transmissions for the Automotive Industry. Theoretical and practical experience essential. Duties will include the supervision of tests and of a proposed dynamometer installation. Excellent prospects, superannuation scheme.—Write in full confidence, stating age, experience, qualifications, positions held, &c., to BOX C.749, c/o Streets, 110, Old Broad Street, E.C.2. E7362 A

DRAUGHTSMAN required for work on varied research projects involving design and detailing of plant and equipment mainly of medium and light engineering nature. Minimum qualifications O.N.C. Mechanical Engineering. Salary not less than A.E.S.D. rates. Pension scheme. 5-day week. Hours 9.0 a.m. to 5.15 p.m. Staff canteen.—Applications in writing to the Administration Officer, The British Iron and Steel Research Association, 140, Battersea Park Road, London, S.W.11. E7368 A

GENERATION ENGINEER

A major British oil company urgently requires a GENERATION ENGINEER to take charge of a gas turbine power station now under construction in India.

Applicants must hold a Higher National Certificate or equivalent in Mechanical Engineering and have at least three years' responsible experience in the operations and maintenance of steam turbines in a modern power station. Experience of gas turbines would be an advantage, but this is not essential.

Age limit : 35 years.

Applicants having some electrical engineering experience would be preferred.

Pay is good, and in addition the company provides free passages, free furnished accommodation, initial kit allowance, six months' leave on full salary and contracts of three years renewable. Free medical attention is available to employees and their dependants.

The successful applicant would be given a short period of gas turbine training and experience at manufacturers' works in this country before proceeding abroad.

Write to Box TE.193, c/o 191, Gresham House, E.C.2, as soon as possible please.

E7373 A

ENGINEER for leading English Company in Uganda. Qualified man 35–40, practical experience of mechanical, electrical and civil engineering, proved salesmanship and administrative ability. Knowledge of cotton machinery and estates, factory construction an advantage. Remuneration dependent on age and qualifications but around £1750 p.a., plus free furnished accommodation, paid home leave and passages, free medical contributory Provident Fund, &c.—Write full particulars to Box ENG. C.757, c/o Streets, 110, Old Broad Street, E.C.2. E7376 A

SITUATIONS VACANT

FORENSIC ENGINEERS invite applications from Engineering Graduates with good background and industrial experience for responsible and individualistic post. Age not over 32. E7259 A

HICK, HARGREAVES AND CO., LTD., SOHO IRONWORKS, BOLTON,
have vacancies for
SENIOR MECHANICAL ENGINEERING DRAUGHTSMEN
for interesting work on large Power Station condensing and feed heating plant. Experience in this type of work is desirable but not essential. Candidates with H.N.C. or equal will be preferred. Practical experience is essential, together with a sound knowledge of pressure vessels and piping layouts.

Pension Scheme carrying free insurance.
Good canteen facilities.
Five-day week.

Applications, stating details of age, experience and salary expected, should be addressed to the CHIEF DRAUGHTSMAN.

E2509 A

JOHN LAING AND SON, LIMITED

have the following vacancies in their Research and Development Centre, at Boreham Wood, Herts.

MECHANICAL DESIGN DRAUGHTSMEN of H.N.C. standard with good experience in the design of building and civil engineering plant.

These posts are progressive and pensionable. The work is varied and interesting and holds attractive prospects in an expanding field.

Canteen and Sports Club facilities. Five-day week.

Apply in writing, stating age, experience, &c., to Personnel Manager (MDD13), John Laing and Son, Ltd., London, N.W.7. E7316 A

JUNIOR SALES ENGINEER (Marine and Industrial), O.N.C./H.N.C., workshop and drawing-office experience ; preferably engineering apprenticeship with practical knowledge of diesel engines ; some commercial and diesel sales experience an advantage. Excellent staff service conditions ; pension and life assurance scheme ; welfare, canteen and sports facilities.—Apply in writing, stating age, experience and qualifications : Labour Officer, BOX JS. 1217, A.K. Advgt., 212a, Shaftesbury Avenue, London, W.C.2. E7361 A

LARGE OIL COMPANY
requires
SENIOR CIVIL ENGINEER
for approximately two years' work on large-scale construction project. Applicants should be corporate members of the Institution of Civil Engineers and have at least five years' site experience on major works in a post of responsibility, either with a contractor or as resident engineer. Experience of large pipe-laying projects or construction of marine jetties would be an advantage. Pay would be in accordance with qualifications and experience but not less than £2500 per annum tax paid.—Applicants should write in detail, quoting No. 925 to Box No. 2836, c/o Charles Barker and Sons, Ltd., Gateway House, London, E.C.4.

E7377 A

MANAGEMENT CONSULTANTS AND INDUSTRIAL ENGINEERS.—A. G. Hayek and Partners, Ltd., have further vacancies in their consultancy organisation. Applicants must have extensive senior work-study experience and be capable of conducting major investigations with policy guidance only. Qualified engineers preferred. Opportunity of advancement to partnership status for men of good personality, eager to take responsibility, who put their career first. Residential appointment in Stoke-on-Trent with little travelling. —Apply in confidence to the above at Federation House, Stoke-on-Trent, giving fullest particulars of background and salary requirements. E2540 A

MANUFACTURING ENGINEERS.—Applications are invited from first class ENGINEERS with sound experience in modern workshop techniques, tooling and process planning, preferably with experience in Medium Heavy Engineering, to fill vacancies as Manufacturing Engineers who are required to give guidance in the production of designs in Drawing Offices. Full details of qualifications, experience, and salary required, should be addressed to the Personnel Manager (JEN), The General Electric Company, Ltd., Erith Kent. E7354 A

PROJECTS ENGINEER (ELECTRICAL).—James Howden and Co., Ltd., have a vacancy for a Projects Engineer to handle contract work in the Precipitator Section. H.N.C./Electrical—or equivalent qualifications required, and some experience in Drawing-Office and contracts work desirable. Duties cover preparation of tenders, and administration of contracts for Precipitator installations. The post carries a good salary, with good conditions and prospects.—Apply, giving full details of qualifications, experience, &c., to Personnel Manager, James Howden and Co., Ltd., 195, Scotland Street, Glasgow, C.5. E7370 A

SALES ENGINEER. We seek a Technical Representative for Birmingham, Warwickshire and Staffordshire ; age around 27-30, not necessarily with previous sales experience but possessing education, alertness, persistence, and integrity which will be well rewarded by good basic salary, commission, car expenses, pension, by progressive engineering company.—Full details of career please, in confidence.—Markland Scowcroft, Ltd., Bromley Cross, Bolton. E2538 A

SENIOR DRAUGHTSMEN required. Must have experience of plant layouts, machine design and pipework installation. Suitable posts for men wishing to broaden experience in a wide range of processing plant. Good, progressive salaries. Staff canteen. Pensions and sickness benefit schemes, &c. —Please apply to Personnel Manager, John Knight, Limited, Royal Primrose Soap Works, Silvertown, E.16. E7382 A

SITUATIONS VACANT

SALES REPRESENTATIVES

Men aged 30/45, with experience of selling to the engineering industry, required for Bristol/Cardiff, Manchester and Birmingham areas. A knowledge of fan engineering and/or dust collection may be an advantage. This is a Senior position with good prospects. Salary in accordance with experience, plus commission. Car or car allowance provided. Send full details of career and experience.—BOX No. E2542, "The Engineer." A

SENIOR CRANE DESIGNER required in West Riding, Yorkshire, with sound knowledge of overhead travelling cranes. Interesting and varied work with good prospects. House provided if necessary. Give full details of experience and salary required.—BOX No. E7220, "The Engineer." A

SENIOR DESIGN ENGINEER, H.N.C. preferred, knowledge of hydraulics desirable and capable of designing, on own initiative, medium heavy machinery.—Apply Mr. Bedford, Chamberlain Industries, Ltd., Staffa Road, Leyton, E.10. Tel.: LEY 3678. E7371 A

SENIOR DRAUGHTSMAN, holding or studying for H.N.C., required by company engaged in design and manufacture of atmospheric and high pressure air and gas dehydration equipment.—Apply in writing to : Chief Engineer, Silica Gel, Limited, Hollygrove Works, Staines Road, Hounslow, Middlesex. E2541 A

SENIOR PROJECT ENGINEER with exceptional experience in the design and modern development of a range of punching, shearing and guillotine machines. The position offered is permanent, progressive and pensionable. The location is near Manchester. A suitable salary is offered to a man with vision and initiative.—Apply BOX No. E7264, "The Engineer." A

WADKIN LIMITED OF LEICESTER (Manufacturers of Woodworking Machinery and High Speed Machine Tools) require a young man as ASSISTANT TO WORKS DIRECTOR. Applicants (age 28/35) with first-class technical and general education should possess a good experience of modern machine shop practice and production methods, preferably in the machine tool industry. They should also possess initiative, drive and personality and be capable of day-to-day management of a works employing 600 workpeople. The post offers a good commencing salary with excellent prospects and a contributory pension scheme is in operation.—Applications, which will be treated in the strictest confidence, giving details of experience and salary required, should be addressed to the Works Director, Wadkin Limited, Green Lane Works, Leicester. E7235 A

WANTED, FIRST-CLASS SENIOR DESIGN DRAUGHTSMAN for firm of General Engineers in Bristol. Good knowledge of general engineering, with particular reference to pressure vessels and stainless steel fabrication. This will be a well-paid position for the top-class man.—BOX No. E164, "The Engineer." A

WEST MIDLANDS GAS BOARD

WARWICKSHIRE DIVISION

VACANCY FOR ENGINEERING DRAUGHTSMAN

DIVISIONAL DRAWING OFFICE—COVENTRY

Candidates should have had sound engineering training and experience in engineering draughtsmanship, structural and building work. They should be capable of carrying out the preparation of drawings, specifications and estimates for the installation of works plant, and the site supervision of large projects. A knowledge of gas works plant would be an advantage.

The possession of the Higher National Certificate in Mechanical Engineering, or equivalent, is essential.

The salary for the appointment, which is pensionable and subject to medical examination, will be within Grade 9 (£827–£927 per annum) of the National Salary Scales for Gas Staffs.

Applications, stating age, qualifications and experience, should be addressed to Mr. A. Allen, Divisional General Manager, West Midlands Gas Board, Gas Street, Coventry, to reach him not later than the 25th September, 1959.

J. SWAN,
Secretary to the Board.

E7359 A

RONEO LIMITED

require DRAUGHTSMEN, both Design and Detail for their programme of expansion in the manufacture of Steel Office Equipment.

Vacancies exist for :

2 Design Draughtsmen, experienced, qualified and capable of development work in this field

and

4 Detail Draughtsmen, with experience , preferred, but applications will be considered from Detailers willing to apply their knowledge and skills.

A Pension Scheme, good working conditions, and salary commensurate to ability are offered.—Please write, giving full details of age, experience, qualifications, &c., to the Personnel Manager, Roneo Works, Romford, Essex.

E7291 A

SITUATIONS VACANT

APC

ATOMIC POWER CONSTRUCTIONS LIMITED

TURBINE DESIGN ENGINEERS

Opportunities exist for design engineers to work on large steam turbines for Nuclear Power Stations.

These are vacancies for men who hold an Honours Degree in Engineering or Higher National Certificate who have served a recognised engineering apprenticeship and have had subsequent experience in the field of gas or steam turbine technology.

Applications, giving full details of age, qualifications, experience, &c., should be sent to :

The Personnel Officer (Ref. 77/E),
Atomic Power Constructions, Limited,
28, Theobalds Road, W.C.1.

E7349 A

SITUATIONS VACANT

MECHANICAL ENGINEERS

not afraid of hard work, required, after preliminary training, to work on own initiative on a wide variety of technical problems. Degree or equivalent, plus basic workshop training. Age under 30.

Write personally, giving full details, to :—

**The Chief Engineer,
HOPKINSONS, LIMITED,
P.O. Box B.27,
HUDDERSFIELD,
Yorkshire.**

E7313 A

SITUATIONS VACANT

ENGINEERS

required by

THE ATOMIC WEAPONS RESEARCH ESTABLISHMENT, ALDERMASTON, BERKSHIRE, to be responsible for the engineering design of electronic and electro-mechanical equipment to suit production and service requirements on the basis of information supplied by the Research and Development laboratories, and to be responsible for the early stages of production.

Successful applicants will be required to develop high-voltage equipment using the latest techniques of miniaturisation and will be expected to bring a lively intelligence to bear on problems associated with the operation of electronic equipment in severe environmental conditions.

A.M.I.E.E., A.M.I.Mech.E. or equivalent qualifications required. Previous experience of this type of work would be an advantage.

SALARY : within the range £845–£1800, according to age, qualifications and experience.

Contributory Superannuation Scheme. A house or substantial assistance with house purchase will become available for married officers living beyond daily travelling distance.

POSTCARDS for application forms to the Senior Recruitment Officer at above address. Please quote ref. A2246/25.

E7372 A

THE GLACIER METAL COMPANY LIMITED, KILMARNOCK

CHIEF WORK STUDY ENGINEER

We are an expanding and vigorous organisation operating in a market where high standards of quality and efficiency are demanded and we recognise the valuable contribution which Work Study can make to the achievement of these objectives.

We seek a CHIEF WORK STUDY ENGINEER to develop further the activities of an established Work Study Department which include subjecting operating techniques to continual review, setting work standards, initiating control mechanisms, improving clerical routines and material handling procedures.

We need an Engineering Graduate or someone similarly qualified who has had considerable practical workshop experience. He must have "fire in his belly" and other qualities which will enable him to make an effective impact on the factory. We would be particularly interested to hear from those who have either worked as Consultants or who have received considerable Work Study training from a reputable firm of Consultants.

This is a senior appointment with a starting salary within the range £1350–£1850. There are excellent opportunities for further advancement.

The factory is a modern one situated close to Ayrshire's holiday resorts.

Applications, containing brief relevant details, including present salary, to :

Personnel Manager,
Glacier Metal Co., Ltd.,
KILMARNOCK.

E7369 A

ATOMIC ENERGY ESTABLISHMENT, WINFRITH

PROFESSIONALLY QUALIFIED ENGINEERS

experienced in the following fields are required for controlling shift operation and maintenance :—

(a) Control of sub-stations and power supplies.
(b) Operation and maintenance of boiler and machinery plant, including pumping and heating and ventilating equipment.
(c) Maintenance of site services, including effluent disposal.

Duties will also involve supporting the Health Physics Organisation, and will require an intensive training course in radiation hazards and their control. Managerial ability is required ; and experience of damage control duties or of work in radioactive areas would be an advantage.

Salary : £1345 to £1800 p.a.

Housing and superannuation schemes.

Send POSTCARD for application form and details to :—

Personnel Branch (W.150/25),
U.K.A.E.A.,
A.E.E.,
Winfrith,
Dorchester,
Dorset,

Not later than 16th October, 1959.

E7343 A

BOOKS and PUBLICATIONS

PITMAN
TECHNICAL BOOKS

FROM ALL BOOKSELLERS

Parker St., Kingsway, London, W.C.2

HELICOPTER DYNAMICS AND AERODYNAMICS

By P. R. Payne. This is the first really comprehensive treatment of helicopter theory by a practising designer of rotary wing aircraft. The most up-to-date book yet on the subject, it contains the first accounts in book form of cantilever, stiff-hinged, high flapping pin offset and other advanced forms of rotor, and also the rotor blade flutter. 84/– net.

THE PERFORMANCE AND DESIGN OF DIRECT CURRENT MACHINES

By Albert E. Clayton, D.Sc., etc. New third edition completely revised by the author in collaboration with N. N. Hancock, M.Sc., Tech. etc. The new edition of this standard work has been brought completely up to date. With the MKS system used throughout, it is an essential book for all B.Sc. (Eng.), Grad.I.E.E., and H.N.C. students. 40/– net.

INTERMEDIATE ENGINEERING DRAWING

By A. C. Parkinson, F.I.E.D., etc. 5th Edition. Here is a new edition of what must be one of the best-known of all engineering drawing textbooks. Thoroughly revised and up to date, this new edition forms, as always, an essential book for all second year O.N.C. students. 12/6 net.

JUST PUBLISHED—
"A complete library in two volumes . . ."

KEMPE'S ENGINEERS YEAR-BOOK

Edited under the direction of the Editor of "The Engineer"

1959 Edition price **82/6** *(plus postage 2/6)*

from technical booksellers or direct from the publishers

Kempe's Engineers Year-Book, 28 Essex Street, Strand, London, W.C.2
Telephone : CENtral 6565

ATOMIC ENERGY ESTABLISHMENT, WINFRITH

A SENIOR MECHANICAL ENGINEER (MAINTENANCE)

is required to be responsible for the site services and to control Sections covering the following fields :

(*a*) the operation and maintenance of boiler plants, air compressors, pumping equipment and various site services ;

(*b*) the erection and commissioning of new plant and the statutory testing of cranes, pressure vessels, &c.;

(*c*) the maintenance and modification of buildings and drainage and road systems, including the effluent discharge system.

Applicants must have served a recognised Engineering Apprenticeship and should be corporate members of the Institution of Mechanical Engineers. Experience should include layout of workshops and test laboratories. A knowledge of working conditions, plant and buildings for radioactive work would be an advantage.

Salary : £1855 to £2155 p.a.

Housing and superannuation schemes.

Send Postcard for application form to Personnel Branch (W.145/25), U.K.A.E.A., A.E.E., Winfrith, Dorchester, Dorset. Not later than October 13, 1959.

E7350 A

Classified Advts. continued on page 154

SITUATIONS VACANT

THE BAHRAIN PETROLEUM COMPANY LIMITED

Require a

MAINTENANCE ENGINEER

This post is open to recent Graduates in Mechanical Engineering, under 28 years of age, who are interested in all phases of planned maintenance of heavy plant and who have preferably some experience on pressure vessel, heat exchanger and pump repair or construction. It is intended that the selected candidate should train in Bahrain with a view to advancement to at least Area Engineer in the large and modern refinery there.

A good salary can be offered, dependent on qualification, in addition to which free air-conditioned accommodation and a living allowance are provided. An initial kit allowance, medical attention, paid home and local leaves are also provided with Participation in Pension and Provident Fund Schemes.

Apply in writing, quoting "MTC," with full particulars, to : Caltex Services Limited, Caltex House, Knightsbridge Green, London, S.W.1.

E7340 A

SITUATIONS VACANT

"VSG" HYDRAULICS

VICKERS-ARMSTRONGS (ENGINEERS), LTD., WEYMOUTH, DORSET

DESIGN DRAUGHTSMEN required. Preference given to those having experience of hydraulic systems and power transmission, and holding H.N.C. (Mechanical). Also two vacancies for ELECTRO-MECHANICAL DRAUGHTSMEN.

Contributory Pension Scheme and Sports Club facilities.

Apply by letter in first instance, giving full details of experience and salary required.

E7285 A

SITUATIONS VACANT

NORRIS CONSULTANTS LTD.,

in view of a two-year expansion programme, require for their London and Bristol Offices and elsewhere in the U.K., Senior and Junior Engineers, Designers and Draughtsmen in the following fields.

CIVIL ENGINEERING DIVISION

Reinforced Concrete, Heating, Ventilating, Air Conditioning, Refrigeration, Pipework and General Services, Structural Steelwork.

PRODUCTION & MECHANICAL DIVISION

Special purpose machines, Transfer Systems, Jigs and Tools, General mechanical, Mechanical Handling, Electrical (Heavy and Light current).

Salary scales up to high level in accordance with age, experience, technical and professional qualifications. Pension and Insurance schemes. Write or telephone Head Office, Beacon House, Queens Road, Clifton, Bristol. Tel. : Bristol 3-6817, or those requiring appointments in London Area, write or telephone : 76, Victoria Street, S.W.1. Tel. : VIC 4675.

E7020 A

APC

ATOMIC POWER CONSTRUCTIONS LIMITED

ENGINEERS

Applications are invited from ENGINEERS to fill vacancies in the following sections :

A Basic Reactor Design Data and Overall Station Performance : duties are concerned with the determination of optimum station and design parameters including both technical and mechanical aspects. Aspects covered include work on steam cycles, heat transfer, fluid mechanics, power station economics and related subjects.

B Reactor Analytical Design : Subjects concerned include heat transfer in graphite structures and pressure vessels, structural analysis, cooling of pressure vessels and concrete structures, and similar problems, often in collaboration with the Company's research laboratories.

Excellent prospects for advancement exist for applicants with initiative and ability for original thought in these wide fields. Both junior and senior positions are available, covering present and advanced reactor types. Good degree or equivalent and experience or knowledge in the subjects mentioned above is desirable.

Applications, giving full details of age, qualifications, experience, etc., should be sent to :

The Personnel Officer (80/E),
Atomic Power Constructions, Limited,
28, Theobalds Road, W.C.1.

E7358 A

STEAM TURBINE DESIGN ENGINEER

Several vacancies exist at Pametrada Research Station for DESIGN ENGINEERS who are interested in marine propulsion. The work is of an advanced nature and a great variety of problems are dealt with, including aerodynamic design and stressing, vibrations, heat balances, &c. Applicants should have a good Engineering degree or equivalent qualification. Some knowledge of marine work will be an advantage. Starting salary will range from £1000 to £1500, depending on age, qualifications and experience. Staff Pensions Scheme and good working conditions. Apply in confidence to the Director, Pametrada Research Station, Wallsend, Northumberland.

E7342 A

FORD

have a vacancy for a

CIVIL ENGINEER

★ Applicants should have completed University or recognised Engineering training and have had sound experience in general industrial works.
★ Ability to supervise new works and capacity for developing administrative services an advantage.
★ Age range 25-35 years.
★ Salary in accordance with experience and qualifications.
★ Five-day week ; non-contributory life assurance and pension scheme.

Please write to

Mr. H. G. Pearman, Training and Recruitment Department, Ford Motor Company Limited, Dagenham, Essex, quoting reference KCE.

E7379 A

SHELL Shell Chemicals

PETROCHEMICALS LIMITED

Applications are invited for the following vacancies in Engineering Department :

A SENIOR ESTIMATOR

A minimum of 3 years' practical engineering and 5 years' estimating experience in the chemical, oil refining or similar industries, is required. H.N.C. or equivalent is desirable and experience with a constructional contractor would be an added advantage. The position will carry the responsibility for the work for the Estimating Section, which ranges from preliminary estimates based on flow diagrams to detailed final estimates, and for developing statistical techniques of estimating based on cost analyses of completed projects.

ESTIMATORS—(2)

A minimum of 2 years' practical engineering and 1 year's estimating experience in the chemical, oil refining or similar industries, is required. A minimum qualification of O.N.C. or G.C.E. "A" level is also required and experience with a constructional contractor would be an added advantage. The work of the Section is outlined above under Senior Estimator.

The positions will carry attractive salaries commensurate with ability and experience. Excellent cafeteria and social and sports facilities are available.

Apply in writing to the Staff Manager, Petrochemicals Ltd., Carrington Works, Urmston, Nr. Manchester.

E7352 A

THE REED PAPER GROUP

has a vacancy for a

Reed PAPER GROUP

QUALIFIED MECHANICAL ENGINEER

Applications are invited for an engineering appointment in the Process Development Section of the Packaging Division Development Department at New Hythe, Near Maidstone, Kent.

A qualified engineer is required for the design and development of transfer and handling machinery. The post will be associated with paper converting batch and continuous in line production plant.

Sound experience and proven ability in the application of handling techniques to high-speed automatic machinery is essential.

Age preferably between 30 and 40 years.

The salary will be commensurate with the qualifications and experience required. A non-contributory pension scheme is operated and assistance with house purchase is available, if required.

Write for application form to :

Packaging Division Development Department,
The Reed Paper Group, Larkfield, Maidstone, Kent,
quoting reference MW/ERM/EH.

E7360 A

SITUATIONS VACANT

Prominent and established manufacturers in London of special purpose precision machinery expect shortly to be appointing a new

CHIEF INSPECTOR

Applications are invited for this extremely important position, which will carry senior executive status and will be remunerative accordingly. The successful candidate, who will take control of an Inspectorate staff running into three figures, will be aged around 40, with technical qualifications in Mechanical Engineering to B.Sc. level, backed by appreciable practical and administrative experience gained in an equivalent capacity in the Machine Tool industry or on a similar type product.

Applicants thus qualified should write in strict confidence, giving all relevant data as concisely as possible, to BOX No. E7347, " The Engineer."

A

ASSISTANT WORKS MANAGER

(SOUTHERN INDIA)

to succeed the present Works Manager of the Indian associate of an international Group manufacturing industrial products and to take charge in due course of a modern and expanding plant employing some 200 people (mainly Indian) situated on the coast 10 miles from a large modern City. Commencing salary in India not less than £2000 p.a., plus bonus, pension, free medical attention, furnished bungalow at low rent, good local and home leave, &c. Preferred age 40–50.

Initial duties will be to undergo period of training in the U.K. to become familiar with the Company's products and methods. This training period, during which salary will be about £1500 p.a., will last 9–12 months and will include a visit to the Indian plant. Thereafter incumbent will be offered a service agreement and proceed permanently to India (free 1st class passages for self and family) to work under the general direction of the Works Manager whose responsibilities he will gradually assume and for which an appropriate and progressive salary will be paid.

Essential qualifications are good engineering background (qualified mechanical or marine engineer preferred), industrial management experience, technical adaptability and willingness to learn. Previous knowledge and experience of India together with a knowledge of Tamil or an aptitude for languages are desirable.

Please write briefly in first instance, quoting Reference No. 231 to :

ASHLEY ASSOCIATES LTD.
PETER HOUSE, MANCHESTER 1.
RETAINED TO ADVISE ON THIS APPOINTMENT
The strictest confidence will be observed and no details of candidates will be passed to clients without candidates' permission.

E7351 A

THE BAHRAIN PETROLEUM COMPANY LIMITED

GRADUATE METALLURGISTS AND MECHANICAL ENGINEERS

are required in Bahrain's modern Oil Refinery for plant and corrosion inspection work. Applicants, under 35, should be familiar with A.P.I., A.S.M.E. codes and have had a minimum of two years' experience in similar work or in the construction and maintenance of fired and unfired pressure vessels, the duties including inspection of vessels, exchangers, pumps, lines, valves, &c., to ensure safe operating condition and the recommending and developing of materials and methods of repair and corrosion control.

Salary would be in accordance with qualifications and experience, but not less than £1332 per annum, in addition to which free air-conditioned accommodation and a living allowance are provided. An initial kit allowance, medical attention, paid home and local leaves, are also provided with Participation in Pension and Provident Fund Schemes.

Apply in writing, quoting " INS " with full particulars, to Caltex Services Limited, Caltex House, Knightsbridge Green, London, S.W.1.

E7339 A

TECHNICAL SALES REPRESENTATIVE

Applications are invited for the post of Technical Sales Representative with a leading firm of pipeline valve manufacturers.

Applicants should be between the ages of 27 and 35 and have a good engineering background. Previous sales experience is very desirable ; initiative, a good personality and the ability to work without direct supervision are essential. This is a responsible position and the successful applicant would represent the Company in Scotland and Northern Ireland.

Remuneration would be by salary and expenses and a Company car would be provided.

The Company offers first-class conditions of employment and housing assistance would be given if necessary.

Applications, giving details of age, qualifications, experience and salary required, should be sent to :—

Sales Manager,
Audley Engineering Company Limited,
Newport,
Shropshire.

E7332 A

FOR HIRE

BELLMANS MASTS FOR HIRE, to lift from 1 to 20 tons, 30ft. to 150ft. Blocks and tackle. Hand-operated winches. From £1 per day.—BELLMAN'S (Phone : SLOane 5259), Hobart House, Grosvenor Place, S.W.1. E103 K

MISCELLANEOUS

DAVIES INVESTMENTS LIMITED, Bankers, still offer 7½ per cent on sums £20 to £500 (withdrawal on demand) with extra ½ per cent on each £500 unit.—Details from Investment Dept., E.R. Davies Investments, Ltd., Danes Inn House, 265, Strand, London, W.C.2. E149 I

BUSINESSES and PREMISES

VICTORIA. In a First Class Building and address, First Floor Offices suitable for Consulting Engineers or Architects. Large Drawing-Office, 3 Private Offices, Central Heating nearly 1400 square feet. 5 years' lease.—Apply : Whatley, Hill and Company, 24, Ryder Street, S.W.1. WHItehall 4511.

E7290 L

SUB-CONTRACTING

CASTINGS.—We can save your porous castings, ferrous or non-ferrous, by an approved impregnation process ; sample castings treated ; A.I.D. approved. —Recupero, Ltd., 66, South Harrow Viaduct, Harrow, Middlesex ('Phone, Byron 1178). E109 MW

KELLERING AND CAM PROFILING capacity up to 8ft. by 6ft. or 6ft. diameter.—ARMYTAGE BROS. (KNOTTINGLEY), Ltd., The Foundry, Knottingley, Yorkshire (Telephone : Knottingley 2743/4). E116 MW

CENTRE LATHES :
Up to 14ft. 0in. dia. by 44ft. 0in. long.
VERTICAL BORING :
Up to 15ft. 7in. dia. by 8ft. 0in. high.
HORIZONTAL BORING :
Up to 8in. spindle, 40ft. 0in. by 20ft. 0in. table.
PLANING :
Up to 34ft. 0in. long by 11ft. 11in. wide by 8ft. 0in. high.
PLANO MILL :
Up to 14ft. 0in. long by 6ft. 6in. wide by 5ft. 6in. high.
SHAFT GRINDING :
Up to 23ft. 0in. long by 2ft. 0in. dia.
SLIDEWAY GRINDING :
Up to 7ft. 0in. long by 4ft. 0in. high by 2ft. 0in. wide.
VERTICAL SPINDLE GRINDING :
Up to 11ft. 0in. long by 1ft. 9in. high by 2ft. 0in. wide.

HARVEY

G. A. HARVEY & CO. (LONDON) LTD., WOOLWICH ROAD, LONDON, S.E.7.

E7256 MW

PATENTS

THE TRADE MARKS set out below were assigned on 31st March, 1959, by Foxboro-Yoxall, Ltd., of Redhill, Surrey, to The Foxboro Company, of Foxborough, Massachusetts, United States of America, WITHOUT THE GOODWILL OF THE BUSINESS IN WHICH THEY WERE THEN IN USE.

Registered No.	Trade Mark	Goods
688991	AIRDRON	Pressure regulators (being parts of machines)
688996	CONSOTROL	Pneumatically operated apparatus for controlling the functioning of manufacturing plant
688997	FLINTEX	Porcelain tubes for pyrometers
688998	PYOD	Thermo-electric couples for pyrometers
688999	LAUNDERLOG	Combined thermometers and liquid level gauges
705080	FOXBORO STABIFLO	Pneumatically operated valves for use in pipeline systems
705081	FOXBORO VERNIER VALVACTOR	Pneumatically operated instruments for controlling the action of valves in pipeline systems

E7384 H

BUSINESS OPPORTUNITIES

REMPLOY SPONSORSHIP SCHEME.—Send for details which show an attractive proposition to manufacturers.—Write to the Managing Director, Remploy, Ltd., 25–28, Buckingham Gate, S.W.1, or telephone VICtoria 6621 (12 lines). E155 G

ADVERTISER, PRIVATE INVESTOR desires to purchase whole or part interest in concern under progressive management making annual net profit of £15/50,000.—BOX No. E163, " The Engineer." O

TO ENGINEERING GROUPS.—Ultra Modern Foundry producing HIGH-GRADE GREY IRON CASTINGS, capacity 200 tons weekly. Would consider amalgamation and/or co-operation. Asset value of freeholds and plant approximately £150,000/£200,000.—BOX No. E165, " The Engineer." O

ENGINEERS with capital willing to purchase controlling interest in Company manufacturing engineering specialities. Replies will be treated in strictest confidence. Reply.—BOX No. E7364, " The Engineer." O

MACHINERY Etc. WANTED

BALL AND ROLLER BEARINGS, &c., WANTED. Also SURPLUS GOODS—especially Hand Tools—of all descriptions.—R. Pordes, 138, New Cavendish Street, London, W.1 (MUSeum 5250). E7330 F

1. **PLATE BENDING ROLLS,** 12ft. by ¼in. capacity, open end with top roll balanced, fully motorised, suitable for 440 volt, 3 phase.
2. **PLATE FOLDER,** 8ft. by ¼in., fully motorised, on swing beam and top bolster.
3. **AN ELLIPTICAL SHEARING AND FLANGING MACHINE,** ½in. plate thickness in mild steel.
4. **UNIVERSAL CROPPING, NOTCHING AND SHEARING MACHINE** with a capacity of minimum of 6in. by 3in. channels and suitable for cropping ¾in. plate.—BOX No. E7367, " The Engineer." F

FOR SALE

FRED WATKINS (ENGINEERING) LTD.

STEAM BOILERS.—Cochrane Vertical (New), 8ft. 6in., 8ft., 7ft. 6in., 7ft. and 6ft. in dia. 100/150 lb. w.p. ; reconditioned 8ft. 6in. down to 3ft. dia. ; Economic 4ft. to 11ft. 6in. dia., including new 7ft. and 8ft. dia., 150, 180 and 200 lb. w.p., 300 reconditioned Vertical Crosstube, all sizes.

AIR COMPRESSORS.—Two Belliss & Morcom 2500 c.f.m., 100 p.s.i., 550 h.p. motors ; also Broomwade 500, 400, 300, 200 and 130 c.f.m., all motorised ; and several others of various makes and capacities.

200 AIR RECEIVERS, stocked up to 9ft. dia., 100 to 500 lb. pressure.

ELECTRIC MOTORS.—150 Totally Enclosed and Flameproof Motors up to 200 h.p.

MOBILE ROAD CRANES.—10-ton Lorain lorry mounted 30ft.–70ft. extendible jib ; 10-ton 33 R.B. track mounted, 40ft. jib ; 8¼-ton Ransomes Diesel/Electric, 21ft. jib ; 6-ton Coles Diesel/Electric, pneumatics, new 1948 (2) ; 6-ton Coles Diesel/Electric, solids ; 4-ton Coles Diesel/Electric, solids ; 1945 ; 4-ton Jones KL44, diesel, 1950 ; 3-ton Jones " Super 40 " diesel, pneumatics (3).

OVERHEAD CRANES.—40-ton Babcock, 40ft. span, 400/3/50, " Goliath " ; 30/5-ton Adamson, 42ft. 3in. span, 400/3/50 ; 20/6-ton Vaughan, 42ft. 3in. span, cab type (6) ; 20-ton King, 42ft. 3in. span, 400/3/50 ; 15-ton Morris, 35ft. span, hand-operated ; 10-ton Morris, 45ft. span, 36ft. lift ; 10-ton Morris " Goliath," 40ft. span, 400/3/50 ; 10-ton Vaughan, 23ft. 6in. span, 400/3/50 ; 10-ton Vaughan, 21ft. span, 44ft. lift, 7½ tons ; Wharton, 25ft. span, 400/3/50 ; 5-ton Henderson, 24ft. 7in. span, 1946 ; 5-ton Morris, 58ft. span, hand-operated ; 5-ton Royce, 2-motor crab, 440/3/50 ; 5-ton King, 29ft. 3in. span, power hoist, hand travel ; 5-ton Morris, 28ft. 6in. span, power hoist, hand travel ; 4-ton Morris, 19ft. span, 220V, d.c. (3) ; 3-ton Adamson, 48ft. span, 400/3/50 ; 2-ton Adamson, 34ft. span, 400/3/50 (2) ; 2-ton Morris, 18ft. span ; 2-ton Vaughan, 27ft. 6in. span, 2-motor ; majority of the above are unused.

DERRICK CRANES.—7-ton Rushworth, hand, 30ft. jib ; 5-ton Wilson, Electric, 70ft. jib ; 5-ton Butters, hand, 45ft. jib ; 1¼-ton Anderson Grice, hand, 40ft. jib.

RAIL CRANES.—18-ton Brownhoist, steam, 50ft. jib ; 10-ton Coles, steam, 40ft. jib ; 10-ton Grafton, 34ft. jib, diesel conversion ; 8-ton Wilson, steam, 35ft. jib ; 5-ton Grafton, 35ft. jib, diesel conversion ; 5-ton Smith, 50ft. jib (2) ; 5-ton Cowans Sheldon, 50ft. jib.

LOCOS.—Fowler diesel, 150 h.p. (2) ; Ruston diesel, 80/88 h.p., new 1942 ; Bagnall 14in. by 22in., two oil-fired, one coal ; Peckett, steam, 7in. by 12in., 1941 ; also 3 miles track, 24in. gauge, Bogies, Turnouts, &c.

STEEL PIPING.—50,000ft., 2in. Galvanised, new ; 60,000ft. 3in. black, new ; 5000ft., 8in. seamless ; 1000ft., 12in. seamless ; 500ft., 14in. seamless ; 400ft., 18in. riveted ; 280ft., 21in. o.d. welded flanged ; 3800ft., 21in. seamless flanged ; 500ft., 24in. riveted ; 1450ft., 27in. o.d. welded flanged ; 216ft., 48in. riveted ; 216ft., 60in. riveted.

CAST IRON PIPES.—Large stocks all size up to 24in. flanged and s.s. Immediate delivery.

VALVES.—Exceptional Surplus Ministry Lot. New Stainless Acid Cocks and Valves, over 5000, immediate delivery, below makers' prices. Large stock all sizes, Parallel Slide Sluices, Gunmetal, Reducing and Check Valves. List on request.

STORAGE TANKS.—300 cylindrical and rectangular up to 12,000 gallons, for oil and petrol, also sectional steel and cast iron up to 50,000 gallons.

MACHINE TOOLS.—Scriven Plate Bending Rolls, 14ft. by ¾in. ; Robertson Straightening Rolls, 8ft. 6in. by ¾in. ; Berry Bending Rolls, 7ft. by ¾in. ; Tangye 200-ton Hydraulic Vertical Straightening Press, 15ft. by 3ft. table ; Herbert 3ND Miller, 61in. by 15in. table ; Pels Punch and Shears, ¾in. capacity ; nine new 2 cwt. and 1 cwt. Pneumatic Hammers ; Bliss 14T Tapering Press ; Bonn Hydraulic Tube Bender up to 20ft. by 4in. bore ; 100-ton Bigwood geared Bending and Straightening Machine up to 12in. by 6in. R.S. Joists ; two 40kVA Spot Welding Machines ; Wire Drawing Machine, 3 die up to ¾in. copper ; 50kW Electric Furnace 1000 deg. Cent., chamber 54in. by 30in. by 21in.

SLING ENGINEERING WORKS
COLEFORD, GLOS.
'Phone : Coleford 2271/2. E106 G

MODERN AIR COMPRESSORS
MOTORISED, 400 VOLT, 3-PHASE
50 CYCLES
100 LB. WORKING PRESSURE

One 540 c.f.m. INGERSOLL RAND type XVH 2-stage with 105 h.p. Slip Ring Motor, completely reconditioned and rebuilt.
Two 495 c.f.m. BROOM AND WADE type EH251 single-stage with 112 h.p. Slip Ring Motors. New 1951. First-class condition.
One 330 c.f.m. BROOM AND WADE type EH241 single-stage with 75 h.p. Slip Ring Motor. New 1951. First-class condition.
Two 300 c.f.m. ALLEY AND MACLELLAN series 23B Size No. 4. 2-stage with 67½ h.p. Slip Ring Motors. New 1951. First class condition.
Three 315 c.f.m. C.P.T. type PB4 air-cooled 2-stage with 85 h.p. Slip Ring Motors and vertical receivers 6ft. by 3ft. diameter. All on bed-plates.
Three 470 c.f.m. " REAVELL " size VS1/6 single-stage double-acting, 40 lb. pressure, with 50 h.p. Mather and Platt motors. New 1950. Almost as new.
One 65 c.f.m. REAVELL type DSA7E, single-stage, 135 lb. pressure, with 21 h.p. Mather and Platt Motor. New 1950. Almost as new.

ATTRACTIVE PRICES—
IMMEDIATE DELIVERY
G. E. SIMM (MACHINERY), LIMITED,
27, Broomgrove Road, Sheffield, 10.

E7282 G

Classified Advts. continued on page 156

FOR SALE

600

STEAM ALTERNATOR SETS

Two 1000kW, 3·3kV, 3-phase, 50 cycles, back pressure type Steam Turbo Alternator Sets, each incorporating turbine by BELLISS AND MORCOM. Speed 4500 r.p.m.; steam pressure 195 p.s.i.g., 380 deg. Fah. temp., exhausting against 15 lb back pressure. Direct coupled through David Brown gearbox to alternator by HARLAND ENGINEERING COMPANY, with direct coupled exciter. Switchgear with automatic voltage regulator. Also with hand-operated overhead crane.

750kW, 400V, 3-phase, 50 cycles, back pressure type Steam Turbo Alternator Set by METROPOLITAN-VICKERS; steam pressure 485 p.s.i.g., 550 deg. Fah., back pressures between 25 and 60 p.s.i.g. Complete with BABCOCK AND WILCOX Water Tube type CT. Boiler, evaporation 20,000 lb/hour maximum, heating surface 3805 square feet, 500/525 lb w.p. All the foregoing forms a complete installation, the boiler grate being suitable for fuel of low calorific value, such as sugar cane, &c.

500kW, 625kVA, 400V, 3-phase, 50 cycles, 4-wire back pressure type Steam Turbo Alternator Set by B.T.H. Speed 3000 r.p.m. Steam pressure 300 p.s.i.g., 150 deg. Fah. superheat, 60 lb back pressure. Complete with all fittings, standard ancillaries and switchgear.

Two 350kW, 400/440V, 3-phase, 50 cycles, Steam Engine Driven Alternator Sets incorporating compound engine by BELLISS AND MORCOM, having h.p. cylinder 18in. bore, l.p. cylinder 26in. bore by 11½in. stroke. Developing 500 h.p. when running at 375 r.p.m. and when supplied with steam at 150 p.s.i. exhausting to back pressures up to 20 lb. Direct coupled to alternator by ENGLISH ELECTRIC, having overhung exciter. Complete with switchgear.

300kW, 440V, 3-phase, 50 cycles, 4-wire back pressure type Steam Engine Driven Alternator Set, with compound engine by BELLISS AND MORCOM. For 140/150 p.s.i.g. up to 25 lb back pressure. Speed 375 r.p.m. Coupled to alternator by ENGLISH ELECTRIC COMPANY with switchgear.

GEORGE COHEN,

SONS AND CO. LTD.
WOOD LANE, LONDON, W.12
(Phone : SHEpherds Bush 2070.)
STANNINGLEY, Nr. LEEDS
(Phone : Pudsey 2241.) E201 G

TWW

NEW RIGIVA MILLING MACHINES

Rapid Power Traverse in all directions.

MODEL U.O.A. PLAIN HORIZONTAL, table 21in. by 8in.

MODEL U.6 UNIVERSAL, table working surface 39½in. by 9¼in.

MODEL U.8 UNIVERSAL, table working surface 47½in. by 11in.

MODEL U.20 UNIVERSAL, table working surface 55in. by 11¾in.

All above with dividing heads and vertical milling attachment.

MODEL V.6 VERTICAL, table working surface 43⅝in by 10⅝in.

MODEL V.20B VERTICAL, table working surface 55in. by 13¾in.

ALL MOTORISED FOR 3-PHASE SUPPLY

THOS. W. WARD LTD.

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OFFER FOR IMMEDIATE SALE
CRANES

NEALS 1-ton "D" MOBILE, 30ft. Lattice, Ruston engine, Pneumatics. 1950. £750.

NEALS "N" 2-ton MOBILE 24ft. Jib, Ruston engine, Pneumatics. £575.

NEALS "NM" 2-ton MOBILE, 35ft. Jib, Ruston engine, Pneumatics. £1450.

BUTTERS 3-ton Electric DERRICKS, 120ft. Jibs, S.L.I's. £1500 each.

MORGAN 5-ton Electric DERRICK, 120ft. Jib, £1450.

COLES THORNYCROFT 5-ton LORRY MOUNTED, 30ft. Jib, Rope, Derricking. £2500.

JONES KL66 6-ton MOBILE, 30ft. Lattice, Perkins engine, on Pneumatics Double Drum with 15/21 Grab, 1956. £4950. Available in 6/8 weeks.

BUTTERS 7-ton 2-motor Electric DERRICK, 120ft. Jib, Rope, derricking. £2500.

RUSHWORTH 7-ton Hand Derrick, 30ft. Lattice Jib. £245.

COLES 10-ton Diesel/Electric LOCO, 40ft. Jib, 4ft. 8½in. gauge, requires overhaul. £1000.

COLES 10-ton Diesel/Electric Mobile, 40ft. Jib. £4750.

ANDERSON 10-ton Electric DERRICK, 120ft. Jib, new 1945. Good condition. £3850.

COLES 12½-ton FULLY MOBILE, 80ft. Jib. £4750.

FOR A COMPREHENSIVE LIST OF PLANT FOR SALE AND HIRE—SEND FOR VALES FREE PLANT REGISTER.

Further details : 14, Lower Grosvenor Place, London, S.W.1. Telephone : VICtoria 7531, 3501, 8080, 9886 (15 lines). E107 G

FOR SALE

Edwards

BRADLEY AND CRAVEN Power Geared Open-Ended Guillotine Shearing Machine, Undercrank type, capacity 84in. by 4in., gap in open ends 4½in., fitted with automatic sheet hold-down and adjustable gauges. Weight approximately 75 cwt.

QUICKWORK No. 32L, Motorised Rotary Shearing Machine, with circle cutting attachment, arranged motor drive for 400/440/3/50, capacity mild steel 14 S.W.G., cuts circles from 6in. to 60in. diameter. Hand feed control lever enables operator to cut intricate shapes by hand. Weight approximately 18 cwt.

NEW BROOM AND WADE Motor Driven Air Compressor Unit, comprising type NX vertical single-cylinder air-cooled compressor fitted with inlet air filter and air governor, capacity 3 c.f.m. delivered at 100 lb p.s.i. pressure, motorised for 380/420/3/50 cycles supply.

RHODES No. 20 size Inclinable Power Press, fitted with Udal automatic press guards, pressure exerted approximately 20 tons, stroke 2in., centre to back 8in., size of bed 22in. by 40in., hole in bed 10½in. by 10½in. Weight approximately 20 cwt.

WESTON Model 400/100, Double-Sided Friction Screw Press of welded steel plate construction, arranged motor drive for 400/3/50, pressure exerted approximately 120 tons, maximum stroke 11in., diameter of screw with four starts 6½in., size of bed 21½in. by 18in. Weight approximately 5 tons.

TWO NEW BESCO Motorised Geared Angle Bending Machines, Undercrank type, arranged motor drive for 400/3/50, complete with top and bottom 90 deg. vee-forming tools, capacity mild steel 5ft. by 14 S.W.G., length of tools 61¼in., stroke of top beam 2½in., maximum daylight bed to top beam 8¼in., number of strokes per minute 21in. Weight approximately 52 cwt.

Photographs of the above are available.

Very favourable Hire Purchase terms can be obtained.

MACHINE TOOLS, NEW AND USED.
Of Every Description. Attractive Prices.

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Telephone : EUSton 4681–3771.
And at
LANSDOWNE HOUSE, 41, WATER STREET,
BIRMINGHAM, 3.
Telephone : Central 7606–8. E207 G

FOR SALE
ASQUITH 5FT. 9IN. PORTABLE UNIVERSAL RADIAL DRILLING MACHINE

spindle No. 4 M.T. mounted on bogie type bed with jack-screws.

F. J. EDWARDS, LTD.,
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LONDON, N.W.1.
EUSton 4681 and 3771.

E7344 G

600

DIESEL ENGINE DRIVEN ALTERNATOR SETS

500kW continuous 400V., 3-phase, 50 cycles, 4-wire BELLISS AND MORCOM/LANCASHIRE DYNAMO COMPANY Diesel Engine Driven Alternator Set, direct coupled at 375 r.p.m. and comprising 7-cylinder vertical engine complete with ancillaries and starting equipment. Direct coupled to alternator with switchgear.

Six 330kVA, 400/440V, 3-phase, 50 cycles, 4-wire self-contained RUSTON PAXMAN type 12RPH2, B.T.H. Diesel Engine Driven Alternator Sets, radiator fan cooled. Each on bedplate and direct coupled at 1000 r.p.m.; electric starting ; standard ancillaries and switchgear.

Two 270kVA, 400/440V, 3-phase, 50 cycles, 4-wire MIRRLEES TL6/BRUSH Diesel Engine Driven Alternator Sets, direct coupled at 600 r.p.m.; standard ancillaries, starting equipment and switchgear. Reconditioned ready for work.

240kVA, 400/440V, 3-phase, 50 cycles, 4-wire DAVEY PAXMAN/METROPOLITAN-VICKERS Diesel Engine Driven Alternator Set, direct coupled at 600 r.p.m.; standard ancillaries, starting equipment and switchgear. Date, 1951.

234kVA, 400/440V, 3-phase, 50 cycles, MIRRLEES Type UA8/METROPOLITAN-VICKERS Diesel Engine Driven Alternator Set, mounted on baseplate and direct coupled at 500 r.p.m.; standard ancillaries, starting equipment and switchgear. Little used.

GEORGE COHEN,

SONS AND CO. LTD.
WOOD LANE, LONDON, W.12.
(Phone : SHEpherds Bush 2070.)
STANNINGLEY, Nr. LEEDS.
(Phone : Pudsey 2241.) E200 G

NISSEN TYPE HUTS for sale. Prompt despatch of 16ft., 24ft., and 30ft. wide huts ; also "Romney" Huts, 35ft. wide, and "Blister" Hangars, 86ft. 6in. and 91ft. wide. These buildings are in various lengths and comprise steel framework with galvanised corrugated steel sheeting.—Full details from Dept. 115, J. Thorn and Sons, Ltd., Brampton Road, Bexleyheath, Kent (Tel. : Bexleyheath 305). E113 G

FOR SALE

HYDRAULIC FORMING AND FORGING PRESSES

3000-ton Down-stroke PRESS for HEAVY PLATE FORMING AND BENDING, rams ; admitting 10ft. 6in. between columns ; bed 16ft by 8ft.,
2000-ton Down-stroke FORGING PRESS, 5ft. stroke ; bed 8ft. 6in. by 8ft. ; daylight 11ft.
1000-ton Down-stroke FORGING PRESS by Wellman, bed 7ft. by 6ft. ; daylight 9ft.
475-ton FLANGING PRESS by Hugh Smith, table 10ft. dia., 4 vice rams.

REED BROTHERS (ENGINEERING), LTD.,
Replant Works,
Woolwich Industrial Estate,
London, S.E.18.
Telephone : Woolwich 7611/6.

E7184 G

PRECIMAX U.P.J.
HYDRAULIC UNIVERSAL GRINDER

Cap. 15in. by 60in. With equipment and 400/3/50 electrics.

H. BELL (MACHINE TOOLS), LTD.,
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E105 G

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For Sale—38″ diameter Electro Magnet and control gear with a 5 kW self-contained Generator powered by a Petter AVA2 Diesel Engine, suitable for Mobile Crane or Excavator.

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E203 G

FOR SALE

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ECONOMIC BOILERS

TWO—COCHRAN "SINUFLO" double pass, 10ft. 9in. diam. × 15ft. 8in. over tubeplates ; evap. 16,800/18,000 lb./hr. ; 120 p.s.i., with chimney, induced draught fans, Thermofeed controls.
ONE—JOHN THOMPSON self-contained, 11ft. diam. × 16ft. over tubeplates ; 120 p.s.i., evap. 14,500/15,150 lb./hr., with fittings and I.D. fan
ONE—DANIEL ADAMSON double pass, 10ft. 6in. diam. × 16ft. over tubeplates ; evap. 14,400 lb./hr., 1160 p.s.i., with feed pump, chimney, grit arrestor induced draught fan.
TWO—JOHN THOMPSON self-contained treble pass super economic, 9ft. 6in. diam. × 14ft. over tubeplates ; 120 p.s.i. ; 9500 lb./hr., with fittings, I.D. fan.
All Suited for Coal or Oil Firing.

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E202 G

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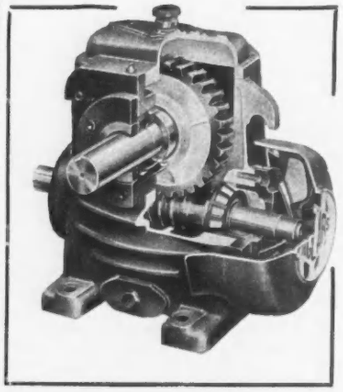
"HIGHFIELD FANCOOL"



Additional Range of SPEED REDUCING UNITS to B.S. 3027: 1958 Standards now available

This range of gear units has been designed in co-operation with the British Gear Manufacturers Association and also The Engineering Equipment Users Association to provide a range of gear units standardised in overall dimensions with other gear manufacturers, yet maintaining our special features for providing the most efficient speed reducer of this type.

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FRED WATKINS (ENGINEERING) LTD.

Fielding 500-ton Vertical Downstroke Hydraulic Press, 42in. by 36in. platens, with pumps and motors.
Fielding 200-ton, ditto, 3ft. stroke, with pumps and motors (5 available).
Fielding 100-ton ditto, 4ft. to 5ft. stroke, with pumps and motors.
Two 73ft. 4in. by 5ft. Kilns or Dryers, with Crofts Reduction Gear and 27 h.p. motor.
Two 26ft. by 4ft. Rotary Cooler or Dryers, with reduction gear and motor.
Available at low prices ex present sites to save cost of bringing into stock.

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AERIAL CABLEWAY.—Reconditioned as new. Electric Radial Aerial Cableway ; load 10 tons ; maximum span 1820 feet ; fixed headmast 125 feet high ; travelling tail carriage 36 feet high ; Igranic contactor control gear ; main cable and all ropes new ; available 3/4 months.—Full particulars from John M. Henderson and Co., Ltd., King's Works, Aberdeen. E2543 G

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Site Area about Three Acres.

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Particulars and Conditions of Sale may be obtained of the Joint Auctioneers :

Chamberlain & Willows, 23, Moorgate London, E.C.2. Tel.: Metropolitan 8001.

Richard J. Francis & Sons, Crown Court, Duke Street, Cardiff. Tel.: Cardiff 21126. E7279 J

By order of the MINISTER OF WORKS Messrs.

FULLER HORSEY SONS & CASSELL

have been instructed to offer for SALE by AUCTION in Lots at LOWERHOUSE FACTORY, PADIHAM, NR. BURNLEY, LANCS., on THURSDAY, 1st OCTOBER, 1959, at 11 a.m. precisely

ELECTRICAL PLANT, STEEL BUILDINGS and MISCELLANEOUS STORES

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Catalogues 1/– each may be obtained, when ready, of Messrs. FULLER, HORSEY, SONS & CASSELL, Industrial Auctioneers, 10 Lloyds Avenue, London, E.C.3.

E7329 J

E R

By Order of the Minister of Supply

GOVERNMENT SURPLUS STORES

SALES BY AUCTION

		Main Location	*Auctioneers*
September 24	Machine tools and miscellaneous stores.	M.O.S. Storage Depot, Rotherwas, Hereford.	RUSSELL, BALDWIN & BRIGHT, LTD. (Dept. L), 20, King Street, Hereford. (Tel.: 4366.)
September 29–30	Machine tools and miscellaneous stores.	M.O.S. Storage Depot, Byley, Nr. Middlewich, Cheshire. (Sale at Cheetham Town Hall, Cheetham, Manchester, 8.)	J. H. NORRIS & SON (Dept. L), 9, Albert Square, Manchester, 2. (Tel.: Blackfriars 8373.)
October 2	Miscellanous stores, including : tool kits ; carpenters' and engineers' tools ; cookers ; clocks ; electric cable ; carpets ; furniture ; folding tables and forms ; kitchen utensils ; blankets ; khaki great coats ; pullovers ; khaki drill clothing ; webbing and camp equipment ; scrap metals ; canvas tents and covers ; etc.	Returned Stores Group, Reed Hall, Colchester, Essex.	FENN WRIGHT & CO., (Dept. L), 146, High Street, Colchester, Essex. (Tel.: 3171.)
October 9	Vehicles and miscellaneous stores.	Central Ordnance Depot, Bicester, Oxon.	MIDLAND MARTS, LTD. (Dept. L), Market Square, Bicester, Oxon. (Tel.: 73.)
October 14	Miscellaneous stores.	Northern Command Ordnance Sub-Depot, Barlow, Nr. Selby, Yorks.	BARTLE & SON (Dept. L), 50-52, Merrion Street, Leeds, 2. (Tel.: 2.0898.)
October 20–23	Vehicles, earth moving and lifting equipment, etc.	M.O.S. Storage Depot, Ruddington, Notts.	WALKER, WALTON & HANSON (Dept. L), Byard Lane, Bridlesmith Gate, Nottingham. (Tel.: 54272.)

Applications for catalogues, available 14 days prior to date of sale, should be made *only* to the auctioneers shown above (price of catalogue 1s. 0d. P.O. only).

SALE BY TENDER

G.M.C. twin 6 Diesel power units complete, model 6046D, approximate quantity—59 and G.M.C. twin 6 Diesel power units complete, 6046/71 series, approximate quantity—78. Location H.Q., M.T. Stores Depot, Bicester, Oxfordshire.

Tenders must be submitted by 2nd October, 1959.

Applications for Tender Forms should be made to the Ministry of Supply, Directorate of Disposals, D.2(a), First Avenue House, High Holborn, London, W.C.1.

E118 J

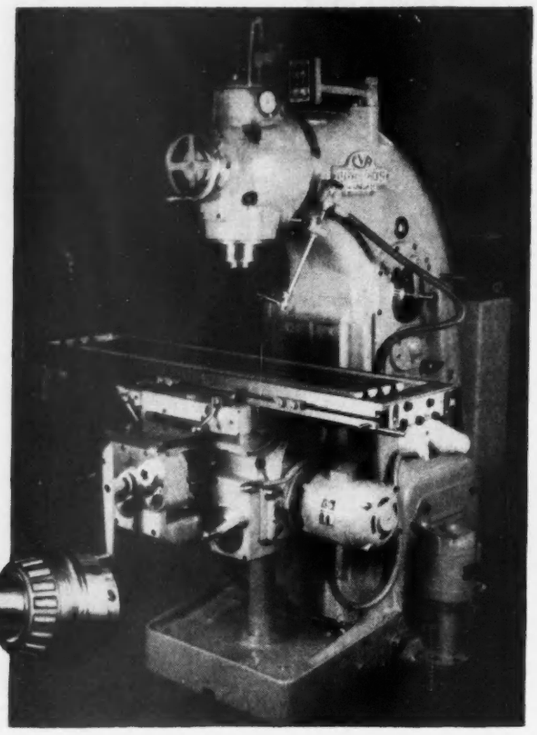
NICKEL ALLOY STEELS

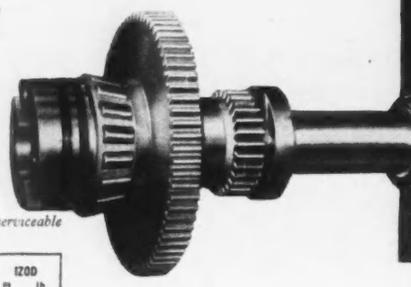
ensure reliability in machining

In the current designs of C.V.A. Jigs Moulds & Tools Ltd., Hove, who concentrate on high speed automatic and centre lathes, dieing presses and 'Milwaukee' milling machines, the constructional materials include various nickel alloy steels for the highly stressed components. The 1¼ per cent nickel-chromium-molybdenum steel, EN 24, one of the most useful compositions, is used for cams, shafts, spindles and other items which are either made from forged material or bar stock.

The reliability of C.V.A. automatics, now operating in thousands throughout the world, is a reflection of the reliability of nickel alloy steels under sustained stresses.

By utilising the better properties obtainable in more highly alloyed nickel steels, dimensions can be reduced, lighter constructions produced, distortion through heat treatment minimised and reliability and economy achieved.





TYPICAL MECHANICAL PROPERTIES OF

EN24

These steels exemplify its versatility both as regards strength and range of serviceable section sizes

SIZE	HEAT TREATMENT	YIELD STRESS t.s.i.	MAXIMUM STRESS t.s.i.	ELONGATION per cent	IZOD ft. lb
0·564" dia.	Oil quenched 830°C. tempered 200°C.	111·4	125·5	14·5	24
1⅛" dia.	Oil quenched 850° tempered 510°C.	79·5	83·6	15	28
1⅛" dia.	Oil quenched 850°C tempered 560°C.	68·2	73·5	19	55
2½" dia.	Oil quenched 840°C tempered 650°C	57·3	64·1	20·5	65
5½" dia.	Oil quenched 830°C tempered 650°C	50·1	58·9	19·5	75

Send for 'The Mechanical Properties of Nickel Alloy Steels' ▶

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TGA 21/20

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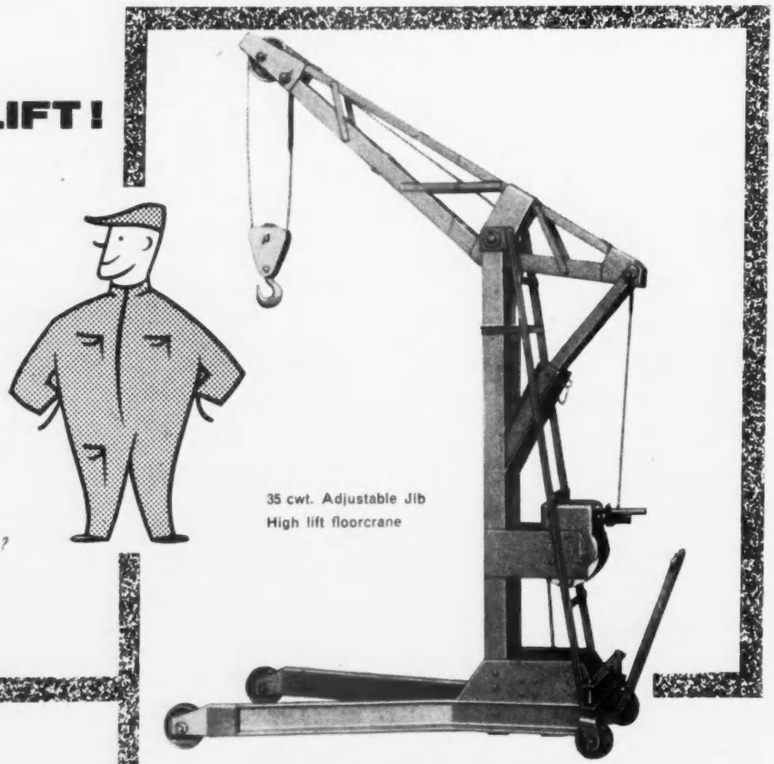

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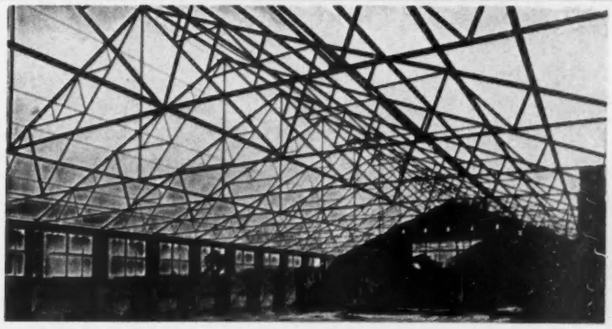

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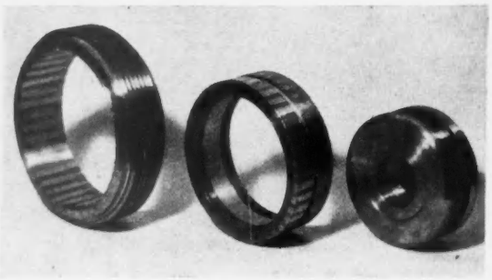

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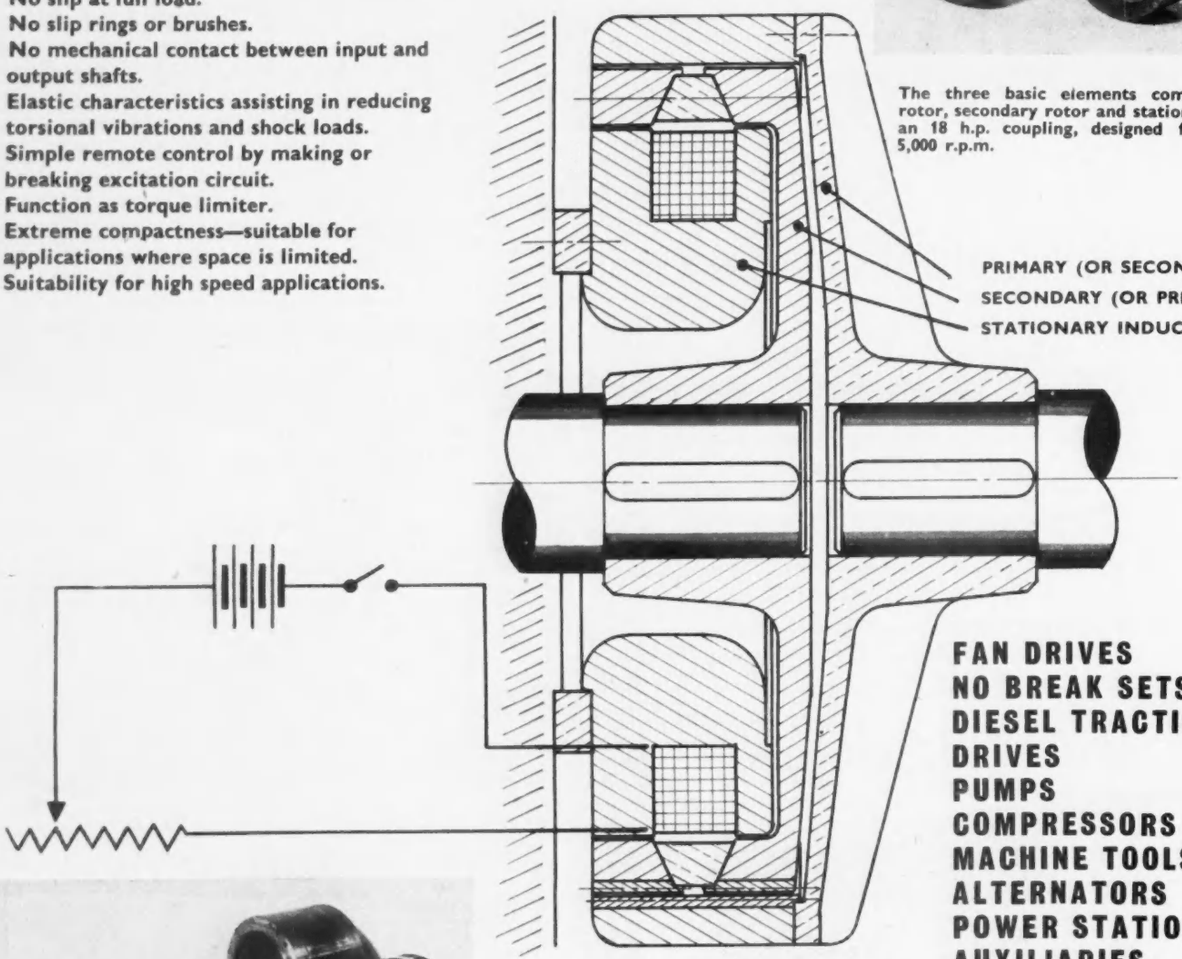

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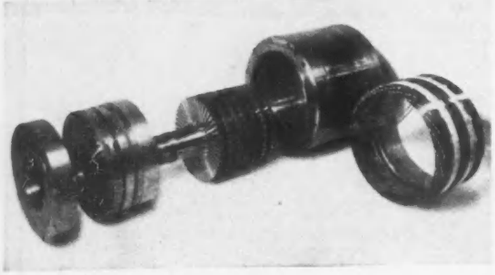

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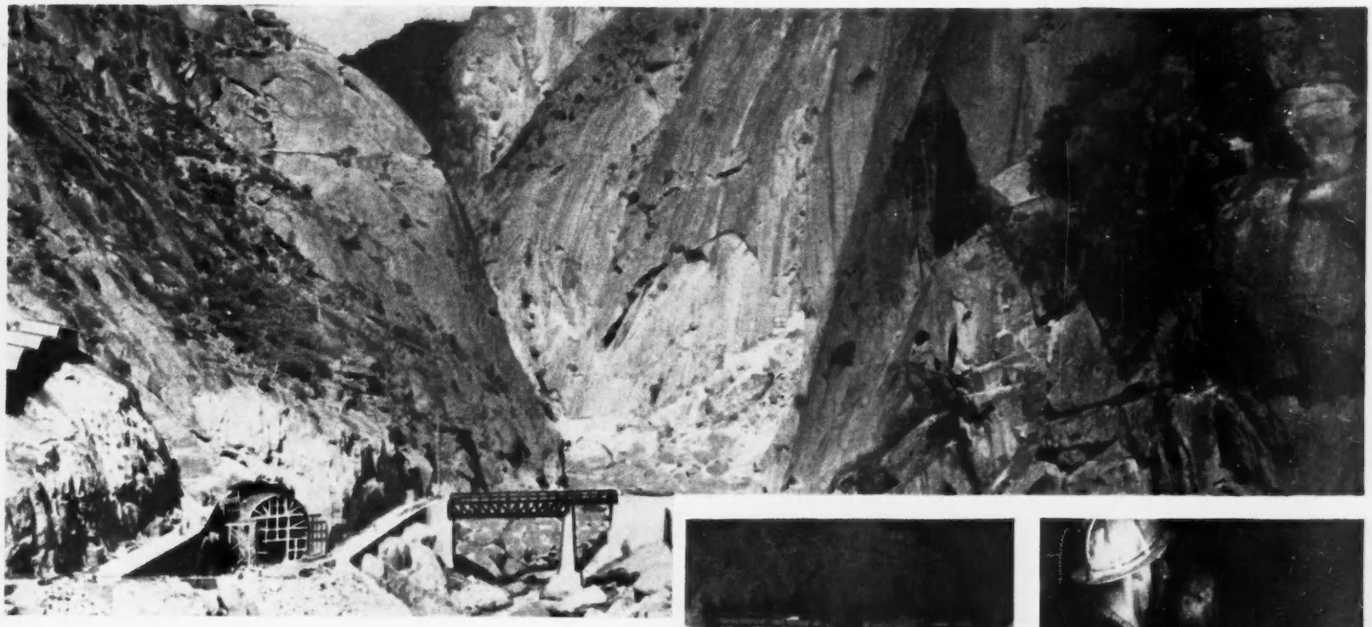

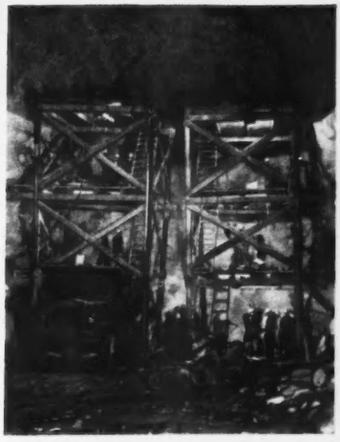

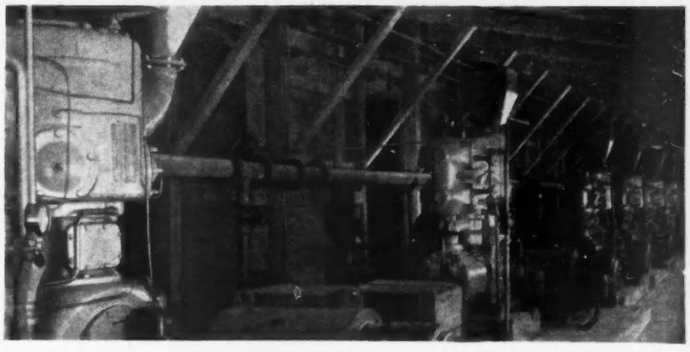

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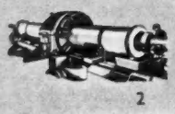
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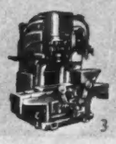
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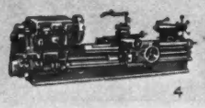
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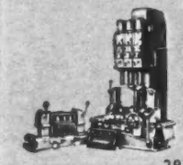
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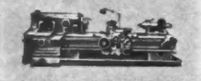
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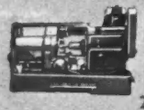
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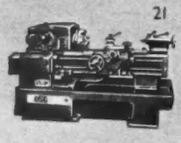
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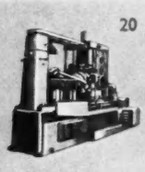
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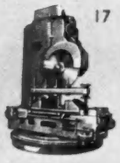
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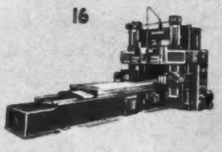
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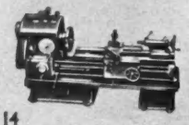
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